MULTI PARAMETER SIMULATOR

LIONHEART

OPERATOR'S MANUAL

BIO-TEK
INSTRUMENTS, INC.

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BIO-TEK ®

MULTIPARAMETER SIMULATOR

LIONHEART

OPERATOR'S MANUAL

MANUAL PART NUMBER 6770006

REVISION H

FOR SERIAL NUMBERS 0300 AND UP

BIO-TEK INSTRUMENTS, INC.

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DOCUMENT REVISION RECORD

Revision, date, and section			Changes
A through D			Revisions prior to document revision record addition.
E	8/15/86	Section 3.0	Step 8: inserted "The arrows . . . on Channel 2." before final sentence in paragraph.
		Section 7.0	Updated specifications.
		Schematics, Component Layout, & Parts List	Updated to current revision level.
F	2/05/87	Title Page	Added FAX number.
G	7/06/88	Title Page & Document Revision Record	Added trademark symbol and statement.
H	1/17/89	Title Page & Document Revision Record	Added Service Department telephone number and changed TM to R (registered trademark symbol).

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1.0 INTRODUCTION

Physiological monitoring systems are used in many parts of the hospital, including the emergency room, operating room, and intensive care unit. Proper functioning of these life support systems is critical. The Lionheart is a multiparameter simulator which allows the operator to simulate two invasive blood pressure waveforms, paced rhythm, ECG, respiration, and temperature. The Lionheart can be used to demonstrate a physiological monitoring system and exercise it to its fullest capacities.

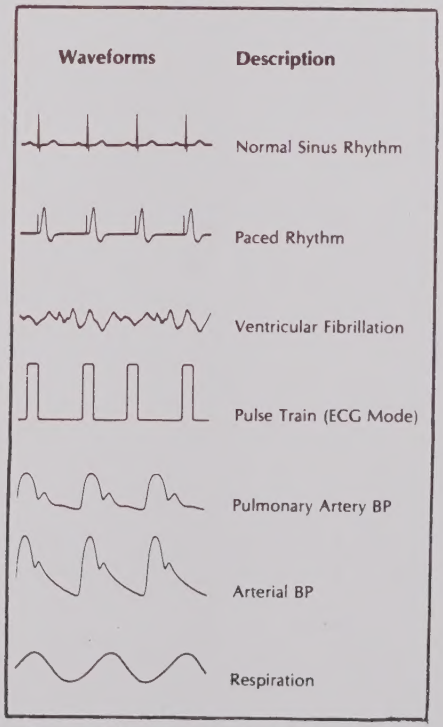
2.0 DESCRIPTION

The Model Lionheart is our most complete patient simulator. The Lionheart is microprocessor controlled with digitally synthesized waveforms. Five different outputs can be simultaneously used, including two blood pressures, paced rhythm, ECG, respiration, and temperature. All output parameters are displayed continuously on a central LCD meter. Power is provided by a single 9 volt battery with external access. This hand-held instrument is completely portable and weighs less than a pound.

The Lionheart was designed to meet the exacting needs of biomedical engineers and technicians, including:

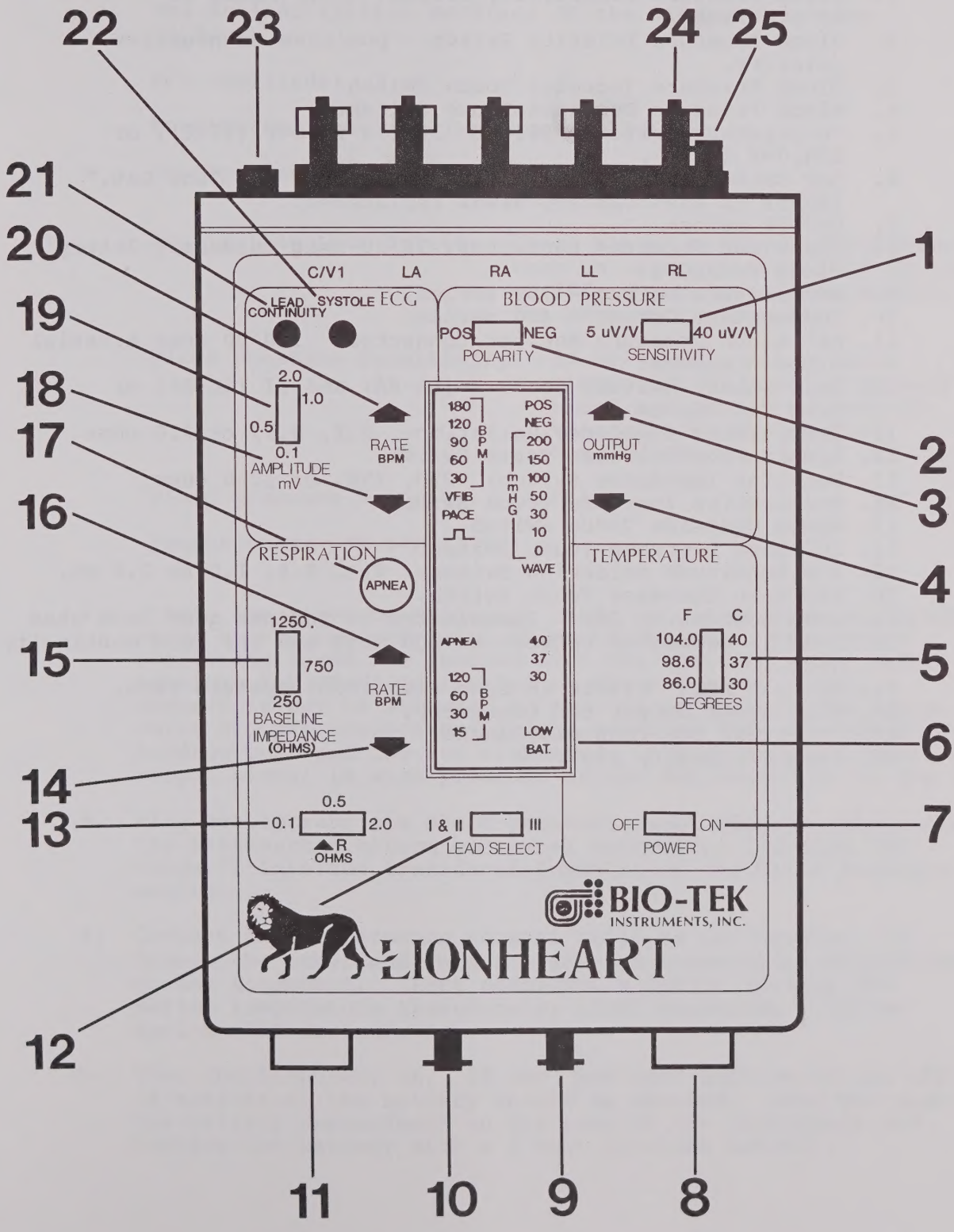
-12 lead ECG simulation
-4 calibrated, static ECG rates
-Normal sinus, pulse train, ventricular fibrillatron, and paced rhythm
-Calibrated dynamic arterial and PA blood pressure waveforms
-13 Calibrated static pressures from -200 to 200 mmHg
-4 Respiration rates with 3 different lead selections
-3 Respiration impedance variations and apnea
-3 Temperatures.

The waveforms generated by the Lionheart are listed below.



A set of 10 ECG jacks allows coupling with all ECG snaps or leads. Prewired BP cables for all major monitor manufacturers are available. Please request the Bio-Tek BP Cable handout which provides all the information needed to select the appropriate cable.

A front panel drawing of the Lionheart is given below. The back panel compartment holds a single 9 volt battery.



Front Panel Call-Outs

1. Blood Pressure Sensitivity Switch: 5 uV/V/mmHg or 40 uV/V/mmHg.
2. Blood Pressure Polarity Switch: positive or negative polarity.
3. Blood Pressure Increase Touch Switch.
4. Blood Pressure Decrease Touch Switch.
5. Temperature Switch: 86.0°F (30°C), 98.6°F (37°C), or 104.0°F (40°C).
6. Low Battery Indicator; a grey area below the "Low Bat." lights up when battery needs replacement.
7. ON-OFF switch.
8. BP2 Blood Pressure Connector: 30/10 mmHg Pulmonary Artery Blood Pressure.
9. Temperature Output - 700 series.
10. Temperature Output - 400 series.
11. BP1 Blood Pressure Monitor Connector: 120/80 mmHg Arterial Blood Pressure.
12. Lead Select Switch. Leads I (LA-RA) and II (LL-RA) or Lead III (LL-LA).
13. Respiration Impedance Variation: 0.1, 0.5, or 2.0 ohms.
14. Respiration Decrease Touch Switch.
15. Baseline Impedance Switch: 250, 750, or 1250 ohms.
16. Respiration Increase Touch Switch.
17. Apnea Override Touch Switch.
18. ECG Rate Decrease Touch Switch.
19. ECG Amplitude Selection Switch: 0.1, 0.5, 1.0 or 2.0 mV.
20. ECG Rate Increase Touch Switch.
21. Lead Continuity LED: Illuminates to indiate good lead when lead is connected between an ECG jack and the lead continuity jack.
22. Systole LED: Blinks in sync with (ECG) systole rate.
23. High Level Output BNC Connector.
24. Universal ECG Connector Jacks.
25. Lead Continuity Jack.

3.0 OPERATING INSTRUCTIONS

1. The nominal initial settings of the Lionheart are as follows:

   ECG Amplitude: 1 mV

   Respiration Baseline Impedance: 750 ohms

   Respiration Delta R: 0.5 ohms (neonatal)
   2.0 ohms (adult)

   Respiration Lead Select: Check manual of the monitor under test to determine the lead (I, II or III) which is used to measure the respiration signal.

   Blood Pressure Sensitivity: 40 uV/V/mmHg (except when simulation of Hewlett Packard blood pressure transducer(s), then sensitivity equals 5 uV/V/mmHg.)

   Blood Pressure Polarity: Positive

   Temperature: 98.6°F (37°C)

2. Attach the electrocardiograph leads to the appropriate binding posts on the top end panel of the Lionheart. The common monitoring leads are labeled with the standard color code. Labeling for V2-V6 is located on the end panel. Snap connectors may be attached to the top of the binding posts, while ECG pin connections may be inserted into the holes on the binding post and the nut tightened. A high level (1 volt) ECG output signal is also provided at the BNC connector in the top.

3. Plug the appropriate blood pressure input adapter cables from the Lionheart's bottom end panel connectors (labeled "BP Output") into the transducer input(s) on the blood pressure monitor.

4. Connect the temperature adapter cable to the monitor and insert the other end into the desired temperature connection on the Lionheart. (Left connector = Yellow Springs 400 series temperature transducers; right connector = Yellow Springs 700 series).

5. Turn the Lionheart on. If the "Low Bat" portion of the LCD is activated, the battery should be changed. Open the door of the battery compartment on the rear of the instrument and replace the battery with a 9 volt alkaline battery.

6. The Lionheart should initialize at an ECG rate of 60 with the "Systole" light blinking at this rate. A Lead II amplitude of 0.1, .5, 1.0, 2.0 mV may be selected with the amplitude switch. The BPM rate may be increased by pressing the "▲" arrow in the ECG section of the front panel. Decrease the rate by pressing the "▼" arrow. Ventricular fibrillation, ventricular paced rhythm or pulse output may also be selected.

   ECG lead testing may be accomplished by attaching the snap connector of the lead to be tested to the right leg binding post and inserting the pin end of the lead into the silver colored tip jack below it on the top end panel. If the lead continuity LED lights, the lead has acceptable continuity.

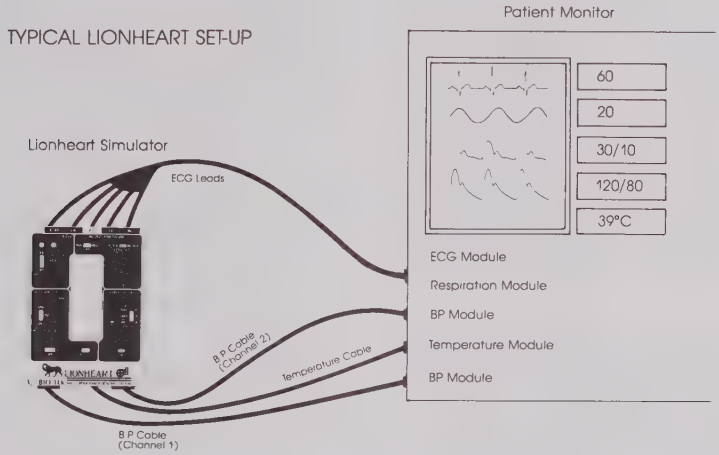
7. The Lionheart should initialize at a respiration rate of 15 breaths/minute. The baseline impedance may be selected at 250, 750, or 1250 ohms. Delta R can be selected at 0.1, 0.5, or 2.0 ohms. The lead select switch may be positioned for Leads I and II or Lead III. The respiration BPM rate may be increased by pressing the "▲" arrow in the respiration section of the front panel. Decrease the rate by pressing the "▼" arrow. An apnea condition may be created by pressing the "apnea" circle.

8. The Lionheart should initialize with the blood pressure at zero for both channels as indicated on the LCD display. This will zero out the BP system and must be done prior to each testing situation. Blood pressure polarity may be selected at either positive or negative and sensitivity at 5 uV/V, or 40 uV/V. The magnitude of the blood pressure output in mmHg may be increased by pressing the "▲" arrow in the blood pressure section of the front panel. Decrease the pressure by pressing the "▼" arrow. The arrows may be used to select **wave**. This produces a radial artery blood pressure waveform on Channel 1 and a pulmonary artery waveform on Channel 2. The blood pressure cable output is as follows:

Pin A	- signal	Green
Pin B	+ excitation	Red
Pin C	+ signal	White
Pin D	- exciation	Black
Pin E	Shield	(bare)

   To get dynamic blood pressure waveform outputs, press the "▼" arrow to get the WAVE mode, below the 0 mmHg.

9. Temperature simulation may be selected at 86.0°F (30°C), 98.6°F (37°C), or 104.0°F (40°C) depending on the position of the temperature switch.

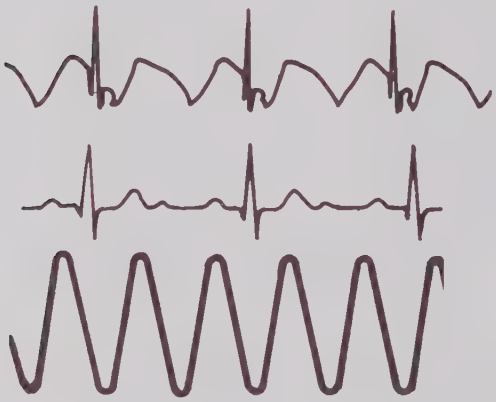


4.0 APPLICATION NOTE

Multiparameter Simulator Model Lionheart

I. Respiration Artifact on ECG Signal

Observation: The ECG waveform simulated by the Lionheart and observed on a monitor appears to have a respiration artifact, as shown below. The artifact is more apparent at low ECG amplitude and high respiration rate.



ECG With Respiration Artifact (Lead III)

Normal ECG Waveform

Normal Respiration Waveform

Cause: This problem exists when the respiration lead select is set to Lead III position. ECG waveform should be observed with the lead select in the Lead I & II position.

Solution: Set respiration lead select switch to Lead I & II position, for the artifact to disappear.

5.0 THEORY OF OPERATION

Refer to schematic for pin numbers and chip designations.

CAUTION: All the digital chips including the processor and memory chips are CMOS and may be damaged by static electricity. To prevent damage, ground yourself before handling the printed circuit boards.

Power Supply and Voltage Reference:

The 9 volt battery is switched on and off by S8. The battery is regulated to 5 VDC to power all circuitry except U13 and Q4 which take their power directly from the battery. Reference chip Q4 and resistor R30 provide a stable 1.23 volt voltage reference which is used by the 5 volt regulator, the D/A convertors, and the low battery sense circuit.

The 5 volt regulator consists of U13C and Q3 with associated resistors. U13C senses the 5 volt output via voltage divider R31 and R32 and compares it to the 1.23 volt reference. If the divided voltage is not equal to 1.23 volts, U13C changes the base drive to Q3 to correct it. C14 and C15 provide output filtering for the regulator and C13 prevents oscillations in the regulator. The regulator is designed to continue working until the battery voltage is only 0.5 volts higher than the output voltage.

As the battery voltage falls lower than about 5.5 volts, Q3 cannot be driven hard enough to maintain 5 volts at the output and hence the voltage at U13C pin 2 drops below 1.23 volts. This is sensed by comparator U13D as a low battery condition. U13D's output goes to input pin 39 of the microprocessor to signal low battery condition. R1 serves as a pullup resistor for U11D when the battery is near 5 volts.

With the use of CMOS digital chips and low power op amps, the battery drain is under 15 mA.

Processor, Memory, and Bus:

The CMOS processor, U1, runs at 6 MHz which is set by the 5 MHz crystal. The frequency of operation is correct if the processor's ALE pin pulsates at 400 kHz ±0.1%. This crystal timing is used by the software to establish accurate rates for the various output waveforms.

The program for the processor and the data for the waveforms are stored in the U2, a 27C16 programmable memory chip. To read a location in memory U2, the processor sends the address of the location it wants over the Bus to chip U3. U3 latches the address upon command of the processor ALE signal. The processor then signals the memory with PSEN to send the program instruction to it over the Bus. The Bus (DB0-DB7 of the processor) is an 8-bit wide, bidirectional data path interconnecting all the main digital chips. The processor controls the direction and use of the Bus by control lines connected to the digital chips. Both memory and

processor chips drive the Bus, and each has a high impedance state to let the other take over the Bus. At times both chips are in the high impedance state and the Bus lines float relative to ground; therefore, a scope attached to a Bus line shows a confusing waveform as the various chips talk, listen, and do nothing on the Bus. Note: A 1X scope probe may load the Bus enough to prevent proper operation.

In addition to the memory and the latch being on the Bus, all the D/A convertors for the analog waveforms and the LCD display latches (U6, U7) are on the bus and controlled by the processor. The D/A's receive their waveform data and the display latches their display data from the processor after it first retrieves it from the memory U2. The D/A's and display latches appear to the processor as memory locations. It selects which chip to write to by first latching an address into U3. U3's outputs go to the chip select input on each individual chip. Then the processor puts the data out on the Bus and strobes the WR line which is common to all the above chips. This causes the data to latch into the selected chip.

Returning to the processor, when power is first applied, capacitor C1 on pin 4 temporarily holds the pin low which resets the processor and restarts the program. Pin 39 lets the processor know if the battery voltage is too low for the voltage regulator. Then the processor will turn on the LOW BAT part of the LCD display via pin 36. Pin 35 provides the square wave to excite the LCD display. Pins 37 and 38 control the most significant bits of the radial artery D/A convertor U8. Pins 25 and 8 are used to trigger one-shots driving the systole light (red front panel LED) and the pacer pulse for the ECG waveform. Finally, pins 27-34 are normally high inputs used every 16 msec to read the touch switches of the front panel. The processsor debounces the switches with software. The APNEA touch switch signal is also inverted and then goes directly to the LCD display drivers to cause the Apnea legend to appear.

Analog Circuits

ECG:

U9 is a dual 8-bit D/A convertor, one half of which procures the ECG waveform and the other half the respiration waveform. The ECG half is connected to produce a waveform voltage at pin 4. This series of steps is smoothed by the active filter built around U13A. The ECG waveform is then summed with the Pacer Pulse input and amplified by U13B. R19 sets the gain for a 1 volt output on the pulse waveform. At this point, the signal goes to the switch pc board and branches out. One branch goes through capacitor C1 to the High Level output jack (BNC type) and the other to the ECG amplitude select switch. Note the value of the selected amplitude is referred to Lead II (LL-RA). Resistors R13 through R24 produce different amplitudes of ECG for each electrode.

Respiration:
The second half of U9 is connected with U12A to produce a negative going waveform voltage at pin 19 of U9. This series of steps is smoothed by R5 and C7 and then applied to FET Q2 as a gate to source voltage. At low amplitudes of drain to source voltage, a junction FET acts as a variable resistor whose value is set by the gate to source voltage. This holds true for both polarities of drain to source voltage. Resistors R7, R8, R10 control the linearity and calibration of the resistance change caused by the gate to source waveform voltage. R9 boosts the total resistance to about 250 ohms.

Looking on the switch pc board, note that FET Q2 and the circuitry described above are in series with the ECG divider chain resistors and either the Right Arm or Left Arm electrode posts (as selected by S4). Thus one of the electrode posts has both an ECG voltage and the respiration impedance signal applied.

Switch S5 connects series/parallel combinations of resistors to the circuitry above to reduce the resistance variation while maintaining a constant baseline impedance.

Switch S6 adds series resistance to the circuitry above to change the baseline impedance.

Blood Pressure:
There are two blood pressure channels each of which is operated independently.

Channel 1 is the more accurate channel and uses a 12-bit CMOS multiplying D/A to produce static calibration pressures and a Radial artery waveform. The D/A functions as a processor-controlled attenuator of the transducer excitation. Because it can function with both positive and negative reference voltages (pin 19), it can handle DC, pulse, or AC excitation. Using a 12-bit D/A insures high accuracy.

Op amp U11 is also highly accurate and buffers the attenuated excitation signal from the D/A. U11's output goes to the switch pc board where it is divided down to transducer signal levels by R25 through R28 with the desired transducer sensitivity selected by S2A. R28 simulates the 350 ohm typical output impedance of a strain gauge transducer.

Returning to U8 and U11, the gain (or sensitivity) is adjusted using R22 which varies the amount of reference voltage U8 sees. R22 and network R21 form a 350 ohm load for the transducer excitation applied by the pressure monitor.

Pot R23 is used to null the input offset voltage of U11. Pot R25 on the switch pc board is used to trim the 5 uV/V/mmHg sensitivity.

A highly accurate and sensitive DVM is required when checking this section of the circuitry.

Channel 2 functions exactly like Channel 1 but uses a low cost 8-bit D/A and U12B. This channel produces a pulmonary artery waveform but not static calibration levels.

Temperature (Located on the switch pc board):
Both Yellow Springs series 400 and series 700 temperature probes are simulated at three temperatures.

Series 400 has only one thermistor and is simulated by one set of resistors switched by S7B.

Series 700 has two thermistors and is simulated by two sets of resistors switched by S7C and S7D.

Grounds:
ECG, blood pressure, and respiration share a common internal signal ground in the MPS. Monitors without isolated front ends will have their grounds connected together when attached simultaneously to the MPS.

The temperature simulation does not share any connections with the rest of the MPS.

Display and Drivers (Located on the display pc board)

The instrument uses a dual bar graph LCD display to back contrast printed legends. The legends correspond to the functional selections the user has made. The display backplane is driven by square wave LCD DRIVE on pins 22 and 23 of the display. When the complementary square wave, LD DRIVE, is applied to a display pin connected to a bar segment, that segment will darken.

The temperature bar segments are selected by temperature select switch S7A which applies LCD DRIVE to the appropriate pin of the display (pins 28-30).

The ECG and blood pressure selections are made using 4051 CMOS multiplexing chips. These decode the address from the LCD display latches and connect the LCD drive to the appropriate display pin.

The respiration selection is similar but the inverted APNEA signal from the APNEA touch switch is the most signficant control bit of the respiration 4051 multiplexer. As a result, the APNEA signal will override the processor's chosen display segment and force the multiplexer to one of its four highest outputs. These are tied together to drive the APNEA segment of the display.

The LOW BAT pair of segments is driven by a buffered square wave LO DRIVE from the processor. The phase of this square wave is shifted 180 degrees relative to LCD DRIVE of the display backplane to turn these segments on.

Finally blood pressure polarity is selected directly by SIC (located on the switch pc board) applying LCD DRIVE to display pin 42 or 43.

6.0 SERVICE INFORMATION

If parts (except for the battery) are replaced in the Lionheart, it must be recalibrated. The unit, therefore, should be returned to the factory for repairs. Pack the unit carefully, insure for full retail value, and return to:

Service Department
Bio-Tek Instruments, Inc.
Highland Park, Box 998
Winooski, VT 05404-0998

(800) 451-5172

7.0 SPECIFICATIONS

ECG

Output waveforms: Pulse Train Amplitude (Select 0.1, 0.5, 1.0, or 2.0 mV.. All are calibrated for Lead II configuration).
- Lead II accuracy ±3% (LL-RA)
- High Level Output 1 volt ±5% (measured baseline to peak)

Paced Rhythm
- Pacer Pulse Amplitude 2 mV ±20% for the 1 mV ECG Amplitude
- Pacer Pulse Width 0.5 msec ±20%

Normal Sinus Amplitude
- Lead II ±10% (LL-RA)
- High Level Output ±10%

Output Rates: ±1% with operating temperature range of 5°-45°C (41°-113°F)

Selectable Rates: 30, 60, 120, 180 BPM's (QRS interval remains fixed)

Output Voltage: 0.1, 0.5, 1.0, 2.0 mV

High Level Output: 1 V peak to peak with impedance less than 600 ohms.

Lead Continuity Test: 10 mA current with LED indicator.

NOTE: Waveform specifications are calibrated to Lead II only.

Blood Pressure

BP1 Channel

Output Waveform: Dynamic Normal (Radial Artery) 120/80 mmHg ±1% of Reading (under output must select wave mode)

Static Pressure: 30, 50, 100, 150, 200 mmHg ±1% of reading; 10 mmHg ±2% of reading; 0 mmHg ±0.1 mmHg

BP2 Channel

Output Waveform: (Pulmonary Artery) 30/10 mmHg ±4% of reading (under output must select wave mode)

Static Pressure: 0 mmHg ±0.2 mmHg (always "Zero" (0) in BP2)

Transducer Sensitivities: 40 uV/V/mmHg or 5 uV/V/mmHg

Rate: 60 BPM (correctly synchronized with 60 BPM ECG for patient simulation)

Load: 350 ohm output simulating transducer

Polarity: Positive & negative (static only)

Respiration

Output Waveform: Physiological

Output: 0.1, 0.5, and 2 ohms change ±10%

Rates: 15, 30, 60, 120 BPM

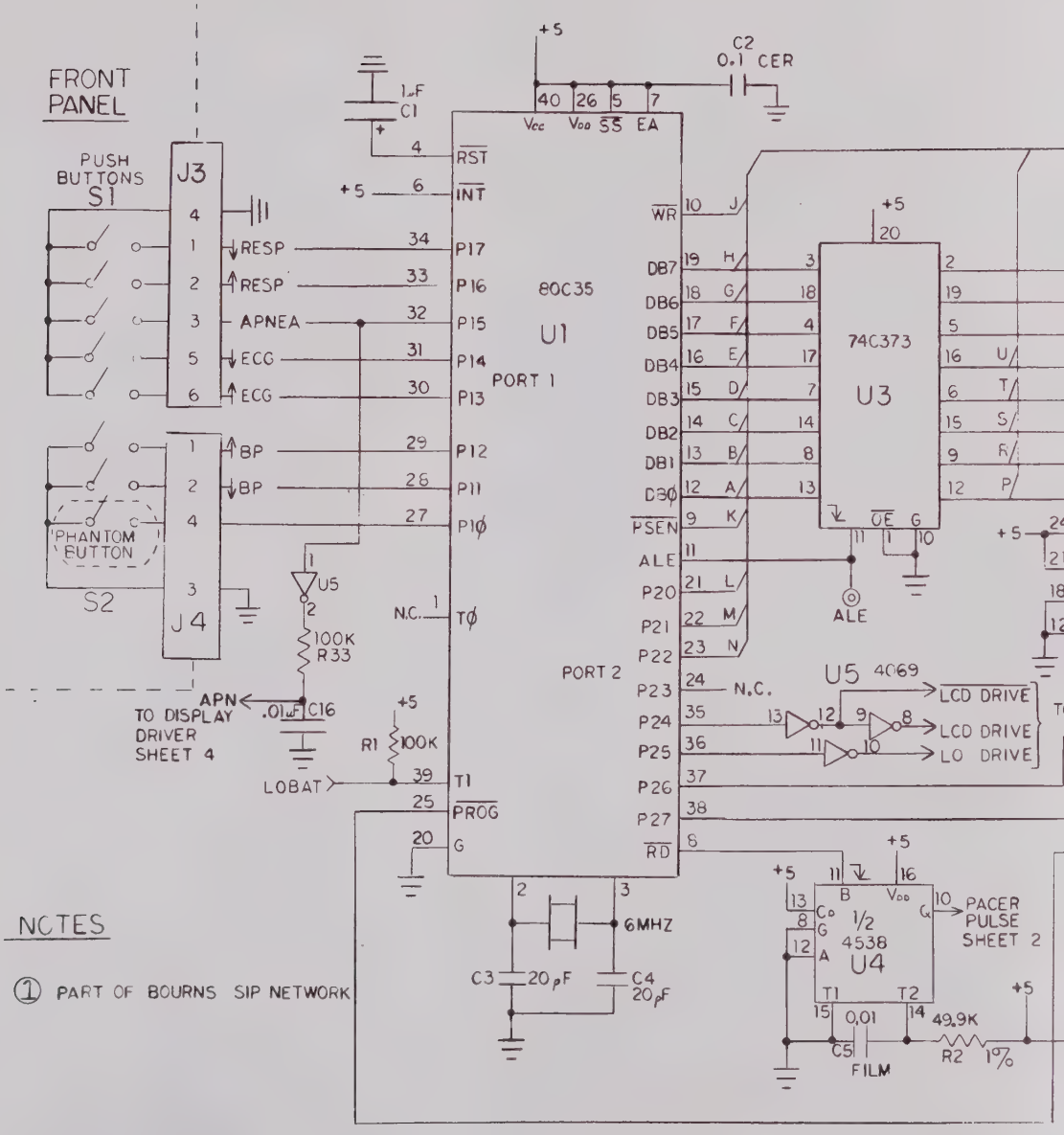
Respiration (cont.)

Signal Selection: LA-RA & LL-RA, or LL-LA (Lead I & II, or III)
Baseline Impedance: 250 ohms, ±10%; 750, 1250 ohms, ±5%
Apnea Button - Freezes waveform until button is pushed a second time.

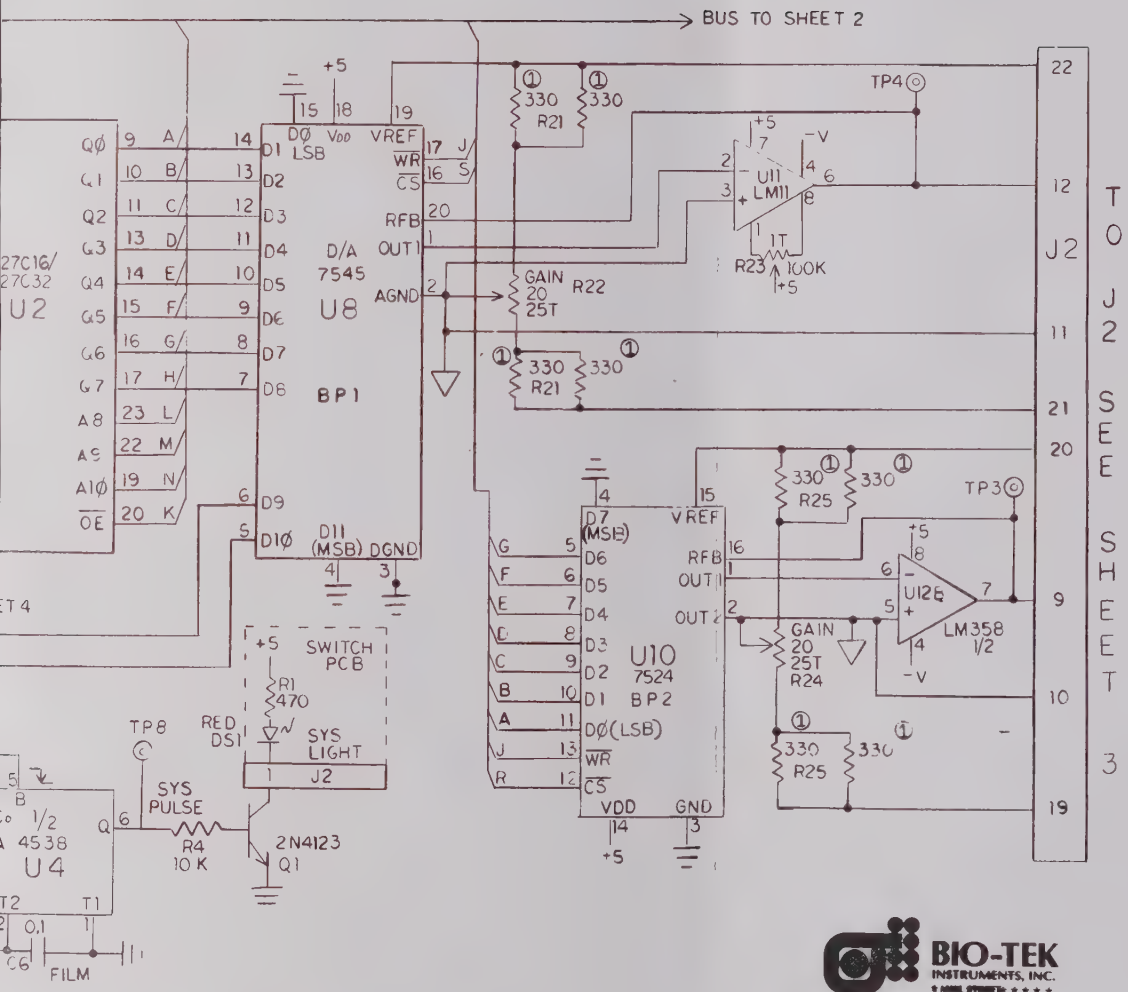
Temperature

Temperatures: 30°C (86°F), 37°C (98.6°F), or 40°C (104°F), ±0.25°C (±0.45°F)
Simulates Series 400 and 700 Yellow Springs thermistor-type probes.

Case: High Impact Polystyrene
Weight: 28 oz (800 g)
Size: 2-1/4" x 5-1/2" x 9" (5.7 cm x 14.0 cm x 23 cm)
Power Supply: "LO BAT" indication goes on between 5 to 5.5 VDC; 9 VDC Alkaline, Duracell MN 1605, or equivalent
Battery Life: 30 Continuous hours.


FRONT PANEL
PUSH BUTTONS S1
J3
J4
S2
PHANTOM BUTTON
RESP
RESP
APNEA
ECG
ECG
BP
BP
U5
100K R33
APN
TO DISPLAY DRIVER SHEET 4
.01µF C16
R1 100K
LOBAT
1µF C1
C2 0.1 CER
+5
80C35
U1
PORT 1
PORT 2
RST
INT
PROG
RD
WR
PSEN
ALE
N.C.
74C373
U3
U5 4069
LCD DRIVE
LCD DRIVE
LO DRIVE
6MHZ
C3 20pF
C4 20pF
1/2 4538 U4
PACER PULSE SHEET 2
0.01 C5 FILM
49.9K R2 1%
NOTES
① PART OF BOURNS SIP NETWORK

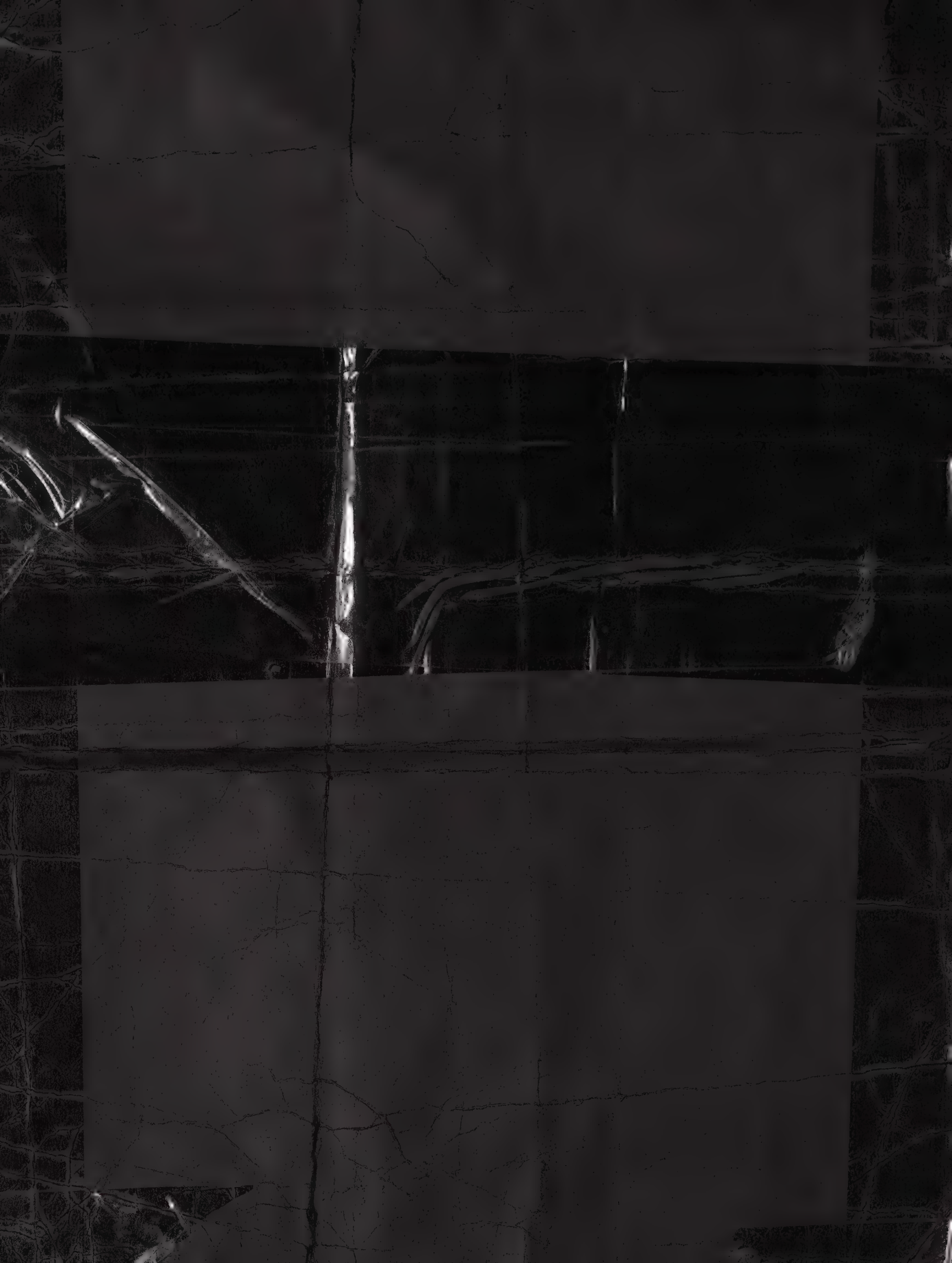
MAIN PCB



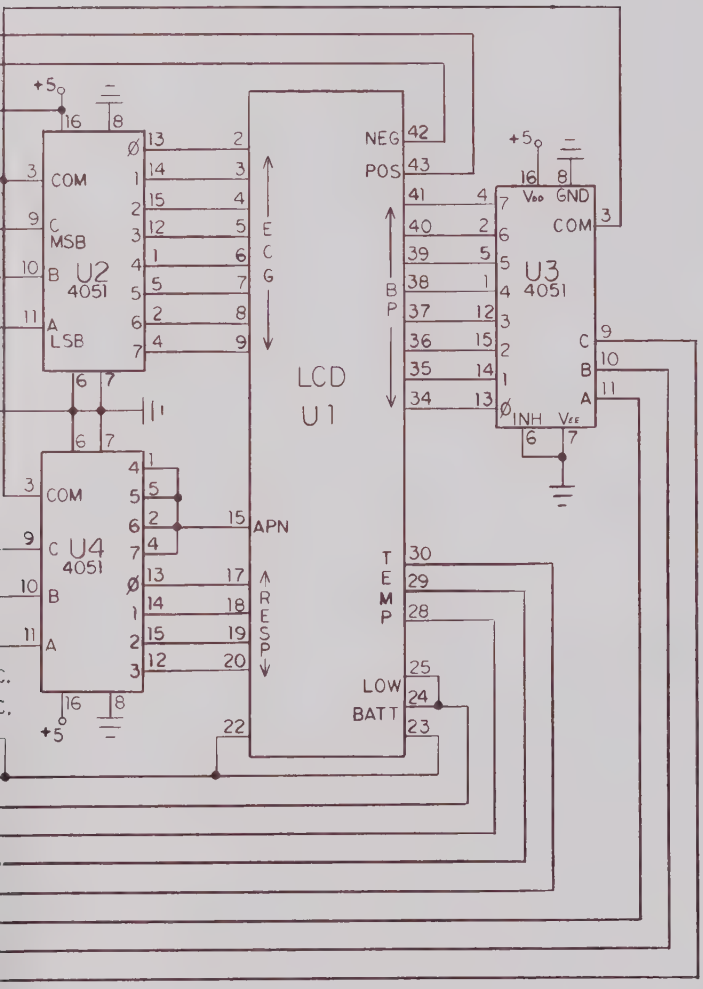
BIO-TEK INSTRUMENTS, INC.
HIGHLAND PARK BOX 996
WINOOSKI VT 05404 0996

REV	DESCRIPTION	DATE
E	Sheet 2 Change R8 to 4.7Ω ECO 1671 Change R10 to 50Ω	1-3-95 JM
D	CH R2 position ECO1240	
C	Add R29 R30 R31 sheet 3 ECO 1231	
B	Add R28 R29 R30 R31 sheet 3 ECO 1231	
A	Release to Production ECO 1230	112383 SP

APPROVALS	DATE	MPS SCHEMATIC	
DRAWN MARRIER	12-7-82	SCALE	DRAWING NO. 6771009-SC
CHECKED		SHEET 1 of 4	



DISPLAY PCB



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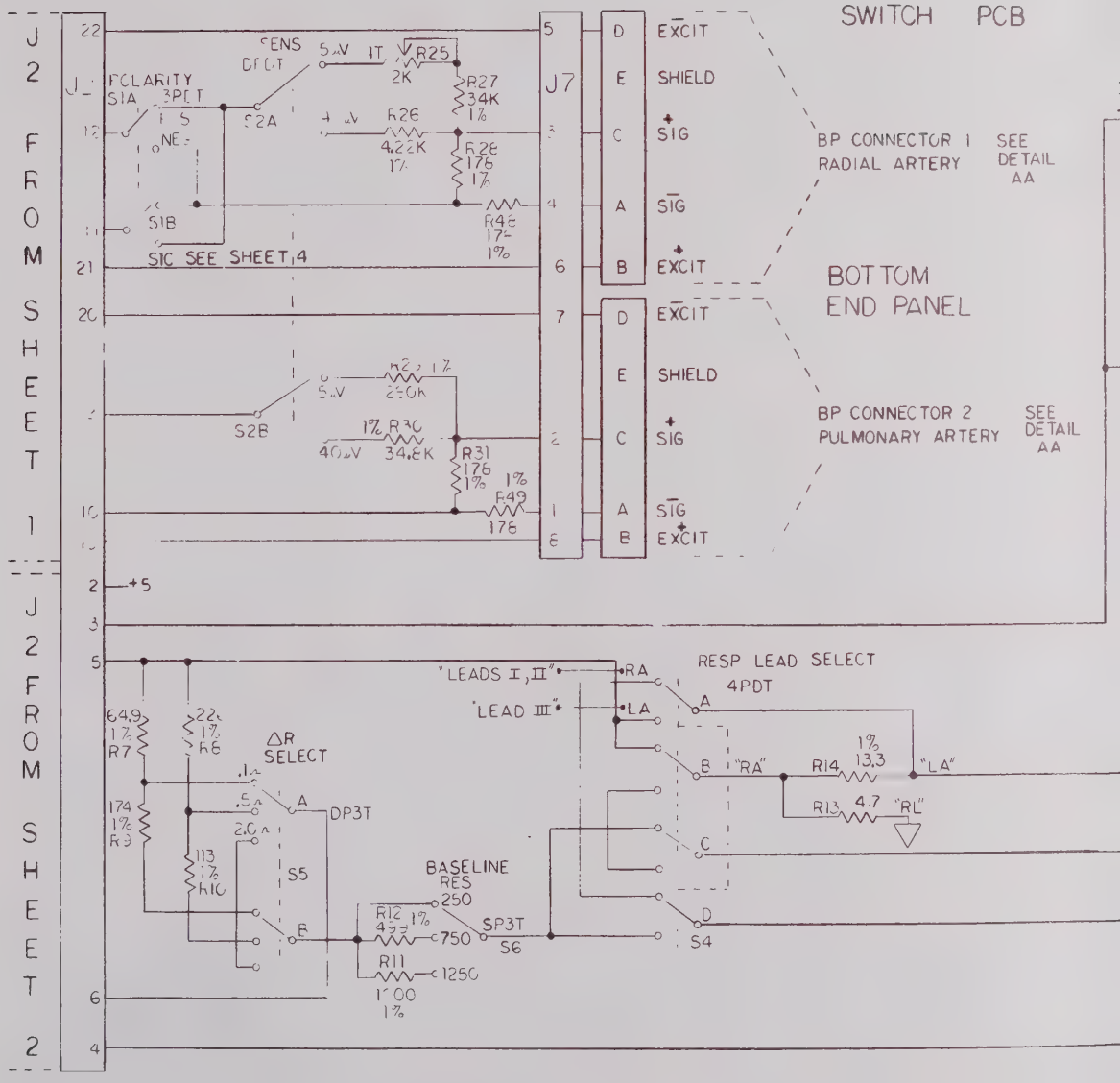
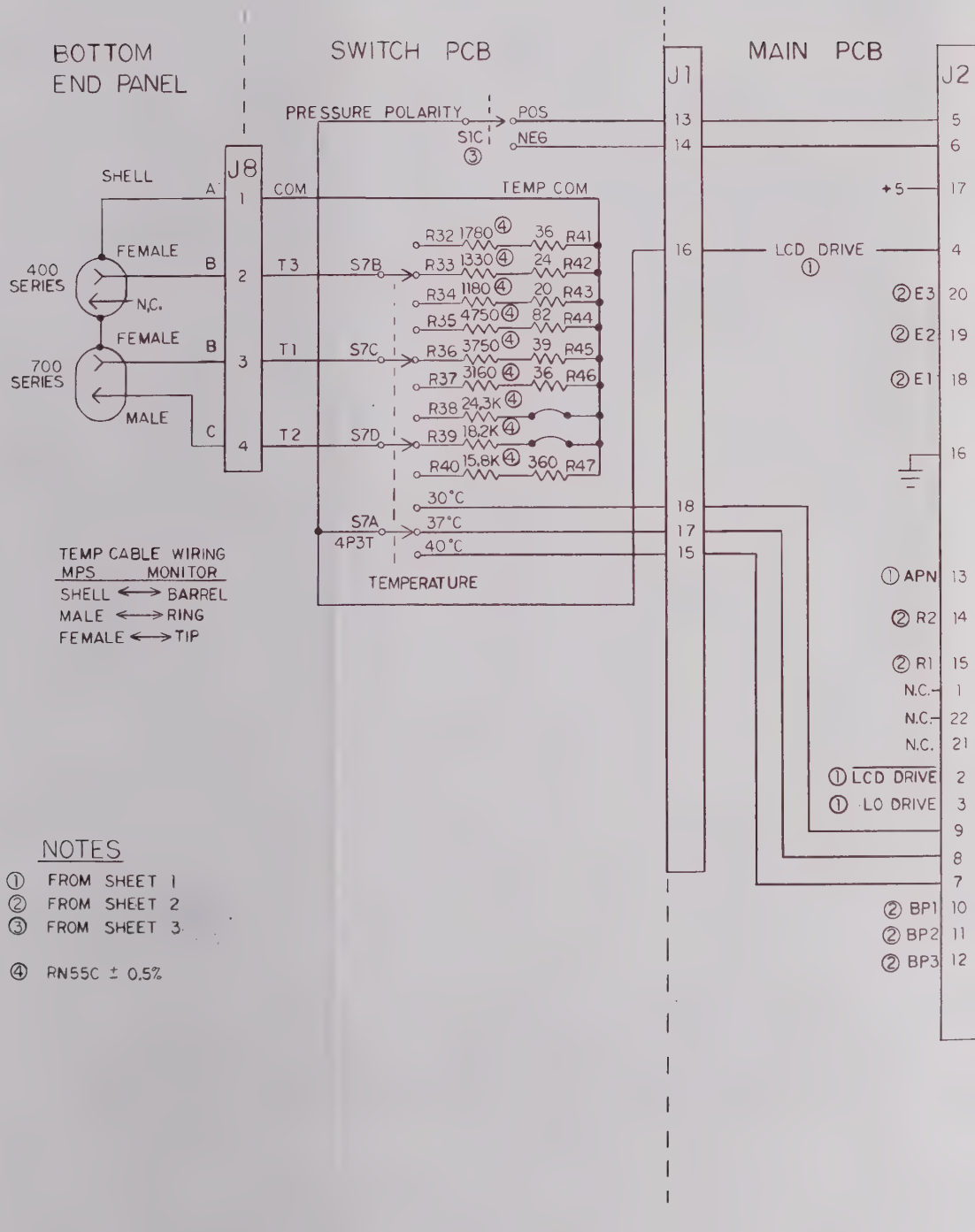
APPROVALS	DATE	MPS SCHEMATIC	
DRAWN MARK 12	12/5/83	SCALE	DRAWING NO. 6771009-SC
CHECKED		SHEET 4 of 4	

REV	DESCRIPTION	DATE
E	SEE SHEET 1	

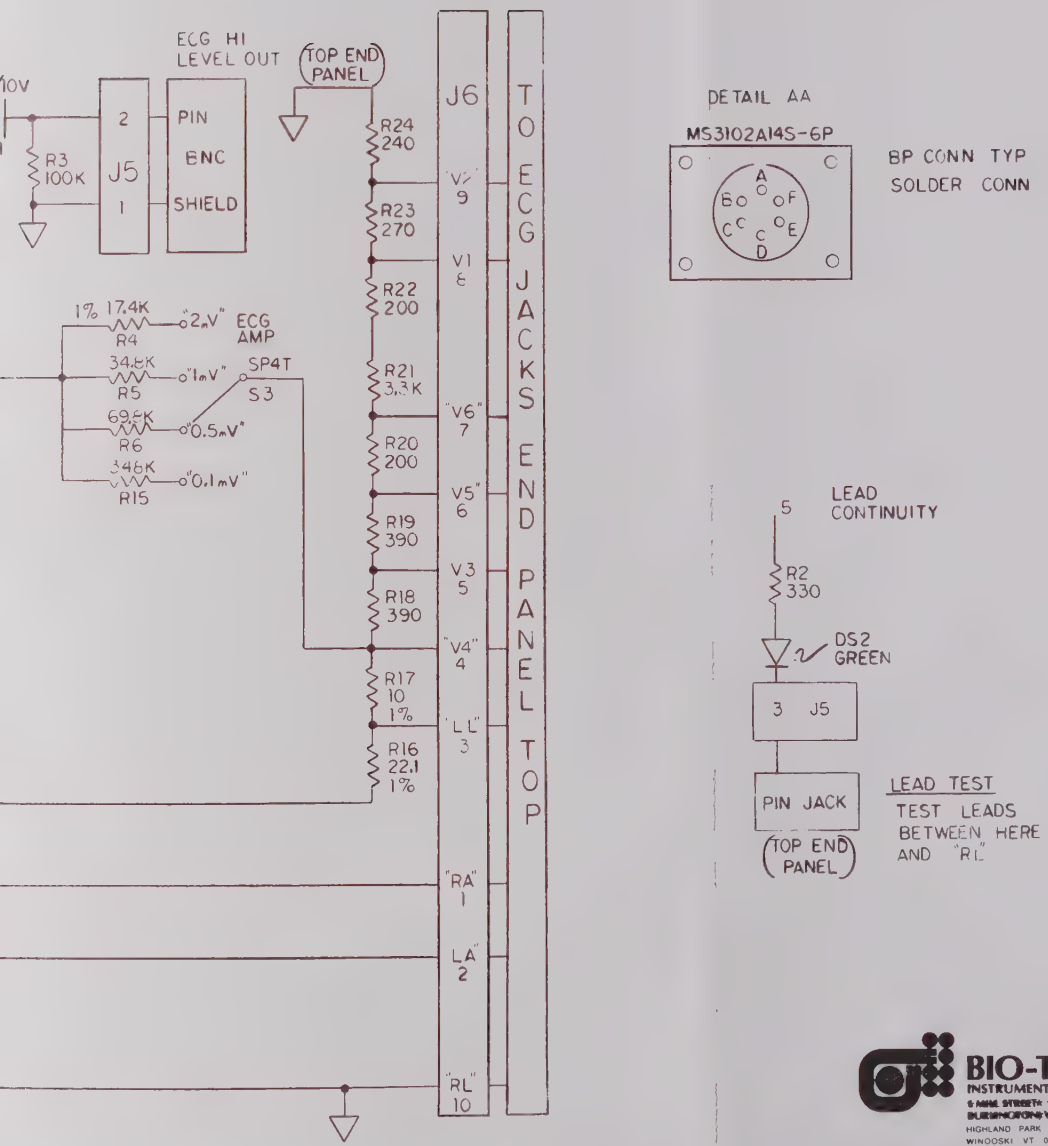

SWITCH PCB
J2 FROM SHEET 1
J2 FROM SHEET 2
J7
SENS DFCT
5 uV IT
R25 2K
R27 34K 1%
R26 4.22K 1%
R28 178 1%
R45 1% 1%
POLARITY S1A 3PDT
S1B
S1C SEE SHEET 4
S2A
S2B
5 uV
R22 1%
2.00K
40 uV
1% R30 34.8K
R31 178 1%
1% R49 178
EXCIT
SHIELD
+SIG
-SIG
+EXCIT
BP CONNECTOR 1 RADIAL ARTERY
SEE DETAIL AA
BOTTOM END PANEL
BP CONNECTOR 2 PULMONARY ARTERY
SEE DETAIL AA
+5
"LEADS I, II"
"LEAD III"
RA
LA
RESP LEAD SELECT 4PDT
"RA"
"LA"
"RL"
R14 1% 13.3
R13 4.7
64.9 1% R7
22 1% R8
174 1% R9
113 1% R10
ΔR SELECT
DP3T
S5
BASELINE RES 250
R12 1% 499
750
R11 1250 1% 100
SP3T S6
S4



NOTES

① FROM SHEET 1
② FROM SHEET 2
③ FROM SHEET 3

④ RN55C ± 0.5%



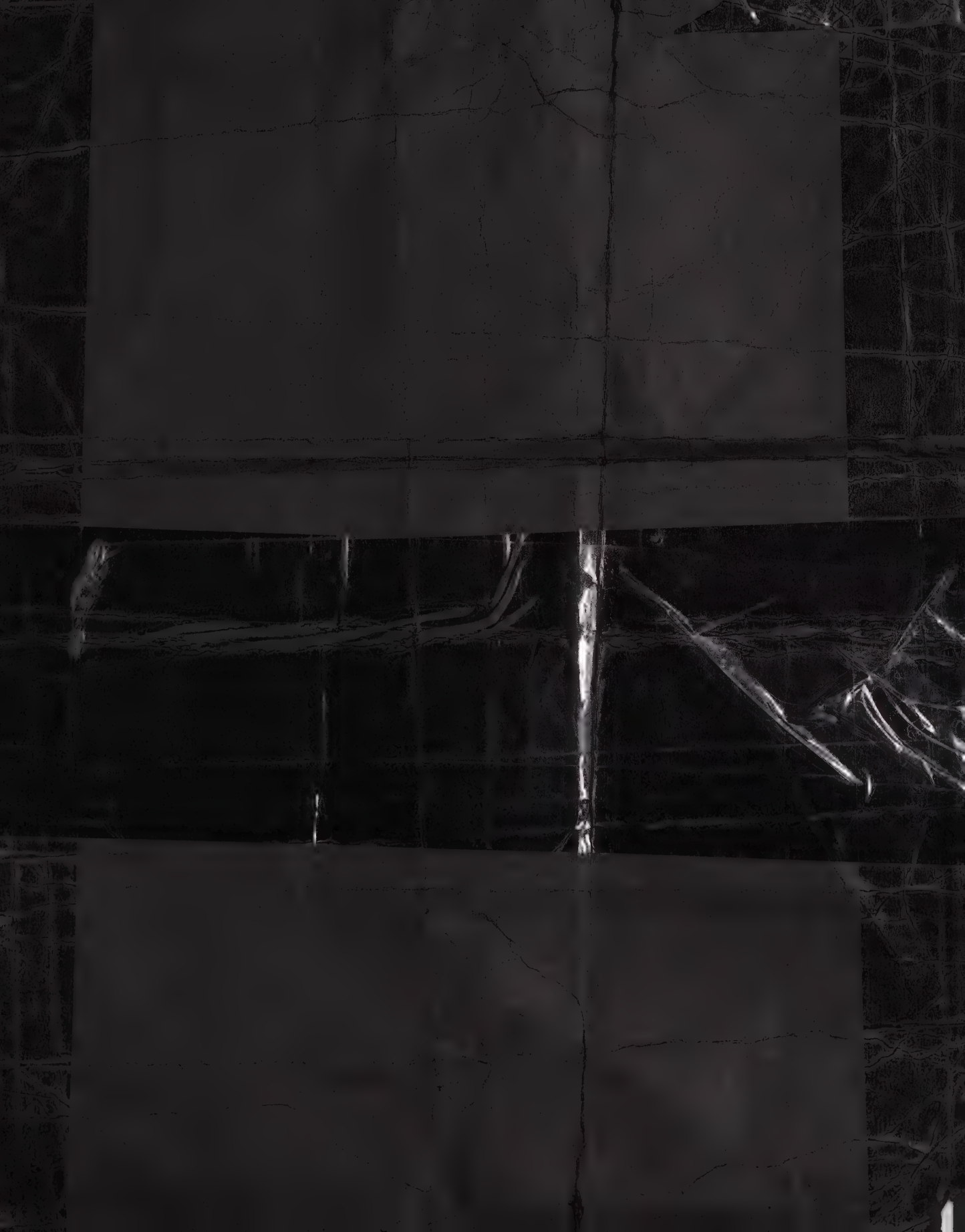
8P CONN TYP
SOLDER CONN

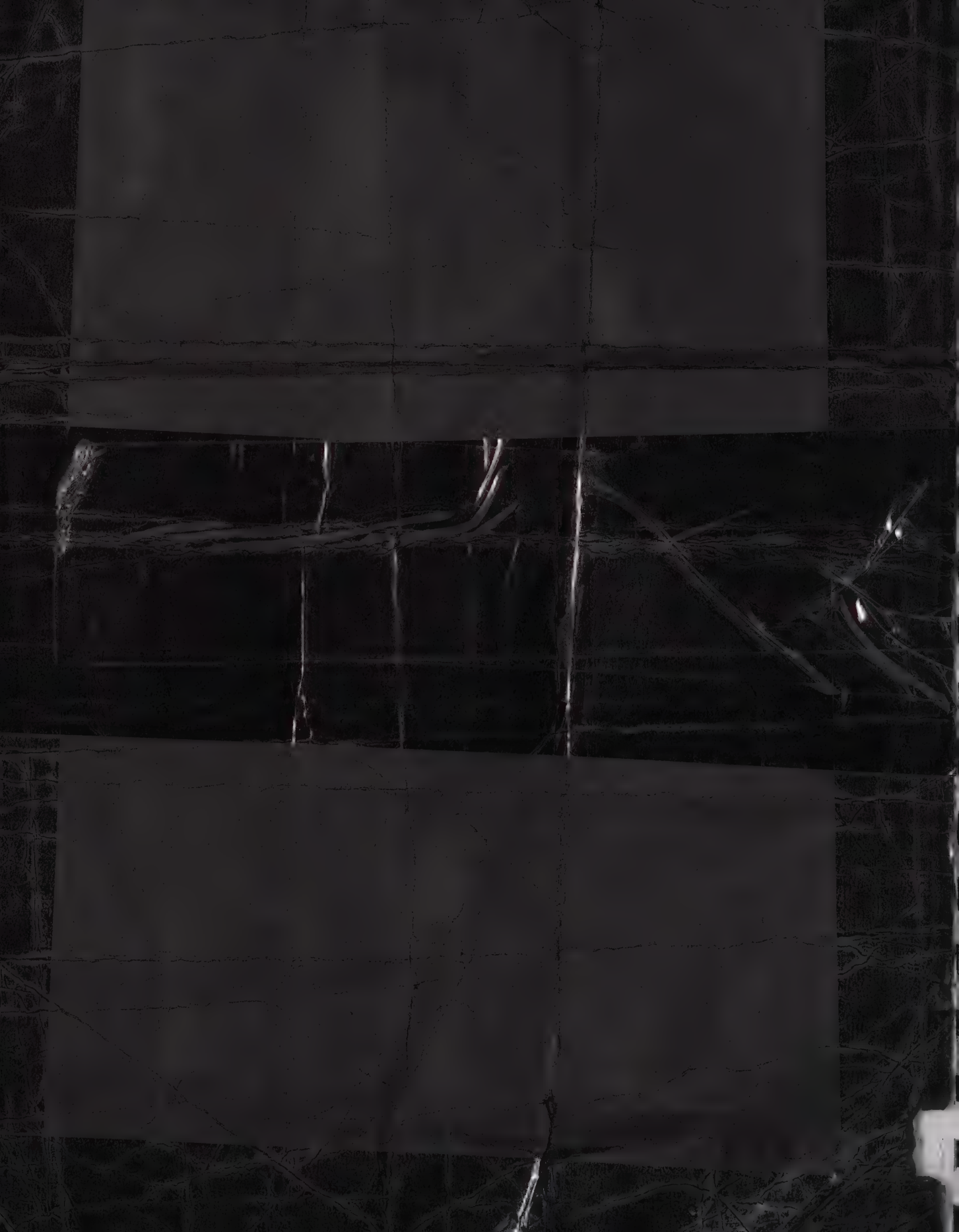
LEAD TEST
TEST LEADS
BETWEEN HERE
AND "RL"

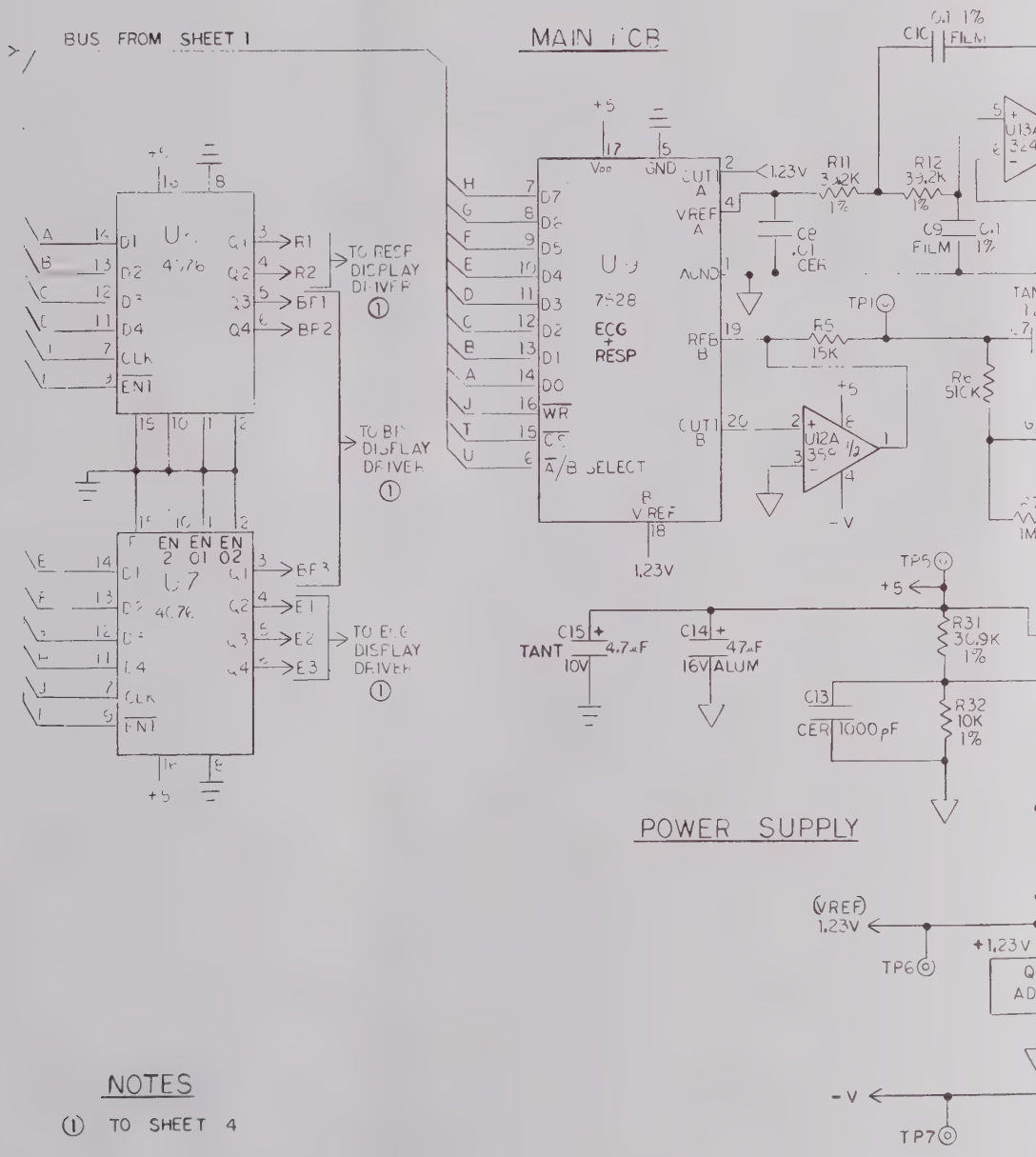
BIO-TEK
INSTRUMENTS, INC.
HIGHLAND PARK BOX 996
WINOOSKI VT 05404 0996

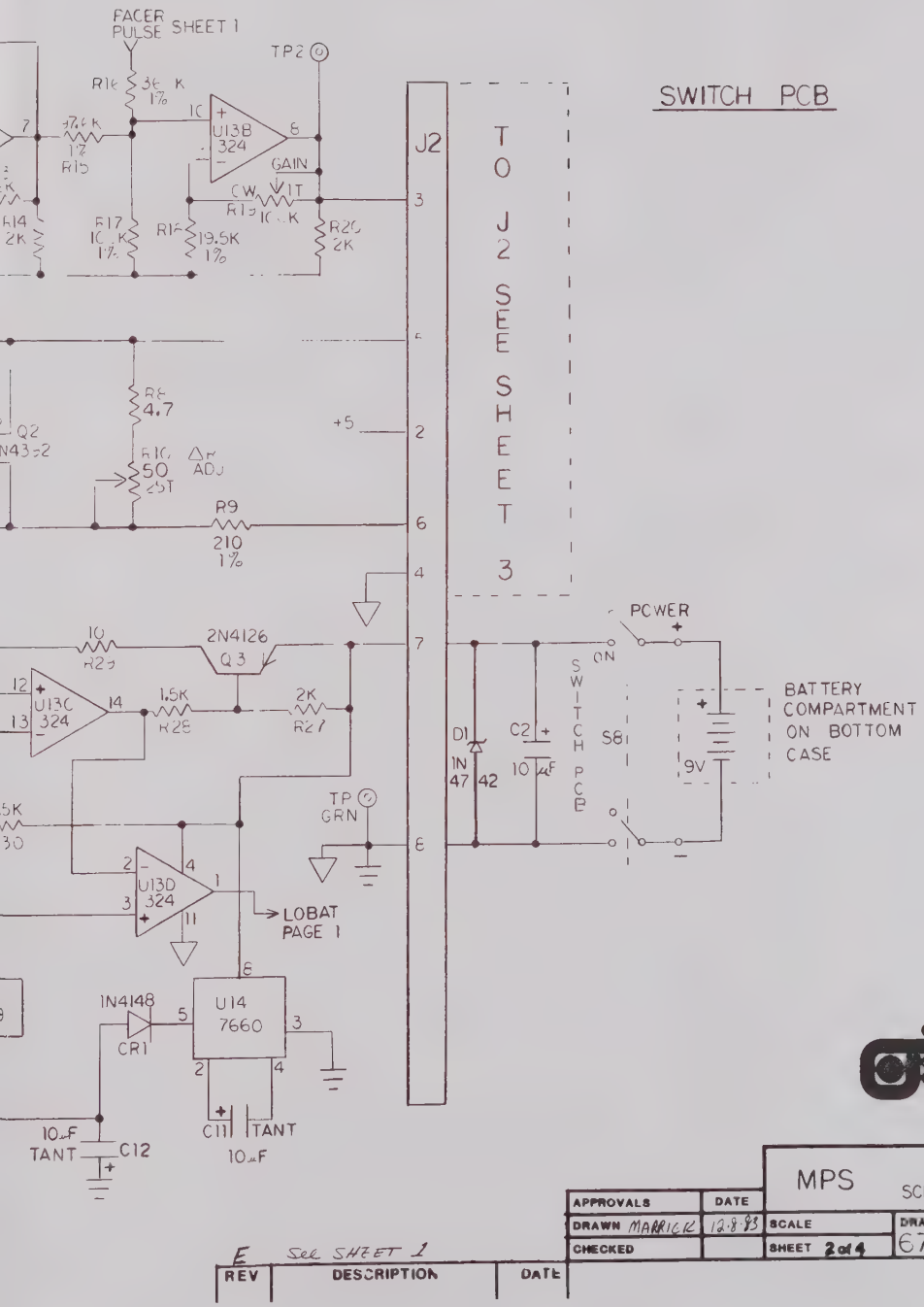
APPROVALS	DATE	MPS SCHEMATIC	
DRAWN MARRIER	12/15/83	SCALE	DRAWING NO. 6771009-SC
CHECKED		SHEET 3 of 4	

REV	DESCRIPTION	DATE
E	SEE SHEET 1	





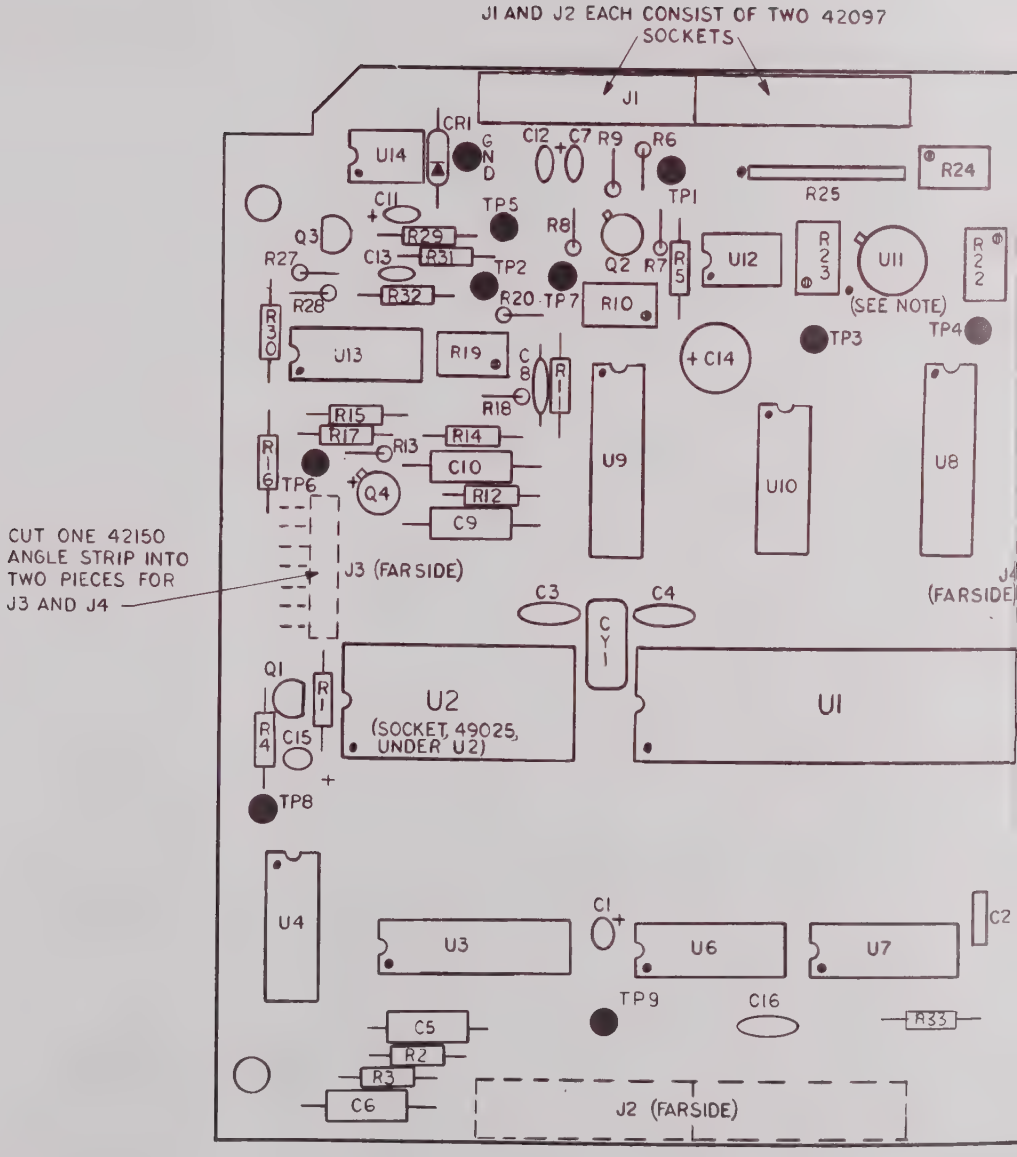

BUS FROM SHEET 1
MAIN PCB
TO RESP DISPLAY DRIVER ①
TO BF DISPLAY DRIVER ①
TO E DISPLAY DRIVER ①
U6 4076
U7 4076
U9 7528 ECG + RESP
U12A 358
R1
R2
BF1
BF2
BF3
E1
E2
E3
R11 3.32K 1%
R12 39.2K 1%
C8 .01 CER
C9 FILM 0.1 1%
C10 0.1 1% FILM
R5 15K
R6 51K
1.23V
TP1
TP5
+5
-V
C15 TANT 4.7uF 10V
C14 47uF 16V ALUM
R31 30.9K 1%
R32 10K 1%
C13 CER 1000pF
POWER SUPPLY
VREF 1.23V
TP6
+1.23V
TP7
NOTES
① TO SHEET 4



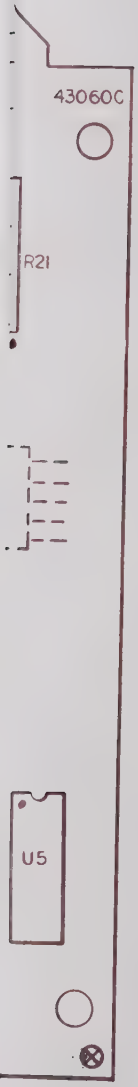
BIO-TEK INSTRUMENTS, INC.
HIGHLAND PARK BOX 996
WINOOSKI, VT 05404-0998

APPROVALS	DATE	MPS SCHEMATIC	
DRAWN MARRICK	12-8-83	SCALE	DRAWING NO. 6771009-SC
CHECKED		SHEET 2 of 4	

REV	DESCRIPTION	DATE
E	See SHEET 1	

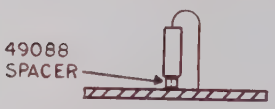

J1 AND J2 EACH CONSIST OF TWO 42097 SOCKETS
J1
CR1
GND
C12
C7
R9
R6
U14
R24
R25
TP1
C11
TP5
R8
Q3
R29
R27
C13
R31
TP2
Q2
R7
R5
U12
R23
U11
R22
(SEE NOTE)
R28
R32
R20
TP7
R10
R30
U13
R19
C8
R11
+C14
TP3
TP4
R18
R15
R17
R14
R13
C10
R16
TP6
Q4
R12
C9
U9
U10
U8
CUT ONE 42150 ANGLE STRIP INTO TWO PIECES FOR J3 AND J4
J3 (FARSIDE)
J4 (FARSIDE)
C3
C4
CY1
Q1
R1
U2
(SOCKET, 49025, UNDER U2)
U1
R4
C15
TP8
U4
U3
C1
U6
U7
C2
TP9
C16
R33
C5
R2
R3
C6
J2 (FARSIDE)

NOTE:



DENOTES PIN 1

R6-9, 13, 18, 20, 27, 28
DETAIL



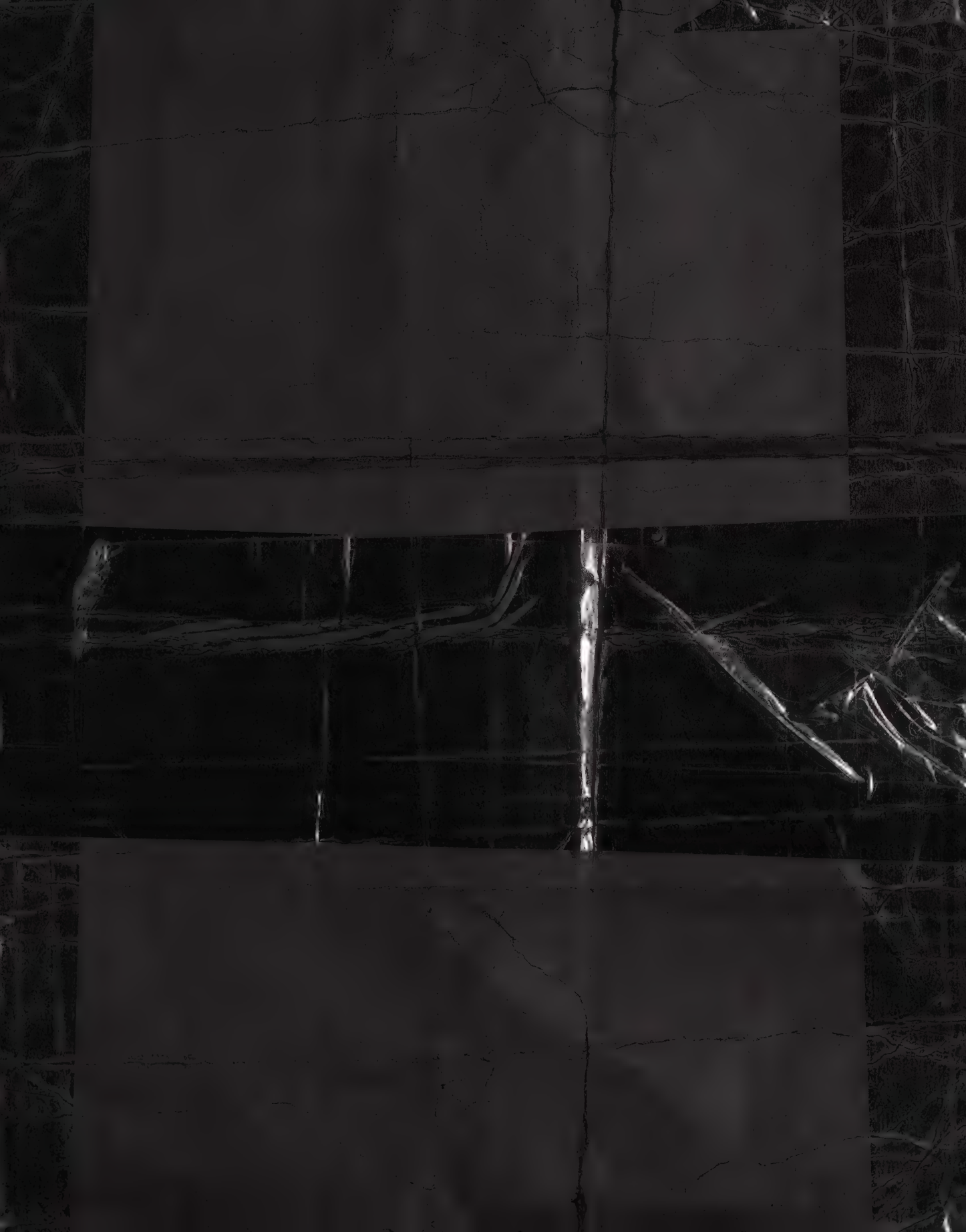
USE 49088 SPACER
EACH LEAD Q2, Q4, CY1

U11 NOTE: THIS MAY BE CAN OR DIP PACKAGE

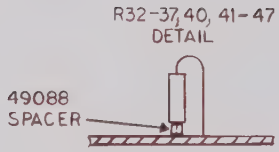
REV	DESCRIPTION	DATE/BY	ECO
E	Add R33 + C16	4/25/85 JJ	2100
D	Delete 49155 sockets & 49056 socket	1-3-85	1677
C	MOVE J1 TO COMPONENT SIDE OF BOARD	11/19/84	1563
B	ADD 43060 B, 49155 NOT 49115, ADD TP9	1/5/84	1175
A	RELEASE TO PRODUCTION		

BIO-TEK
INSTRUMENTS, INC.
[redacted]
HIGHLAND PARK, BOX 996
WINOOSKI, VT 05404-0998

APPROVALS	DATE	MAIN PC BOARD ASSEMBLY	
DRAWN SP	7/15/83	SCALE 2 TO 1	DRAWING NO. 6771001-AS
CHECKED		SHEET 1 OF 1	



ABLE (2)



REV	DESCRIPTION		DATE/BY
D	CHANGE 71005 TO 71015	ECO 3573	6-26-862
C	ADD R49 & R48	ECO 2157	4-23-85 AM
B	ADD C2 AND D1	ECO 2082	4/17/85
A	RELEASE TO PRODUCTION	ECO 1149	10/17/83

BIO-TEK INSTRUMENTS, INC.
HIGHLAND PARK BOX 866
WINOOSKI VT 05404-0866

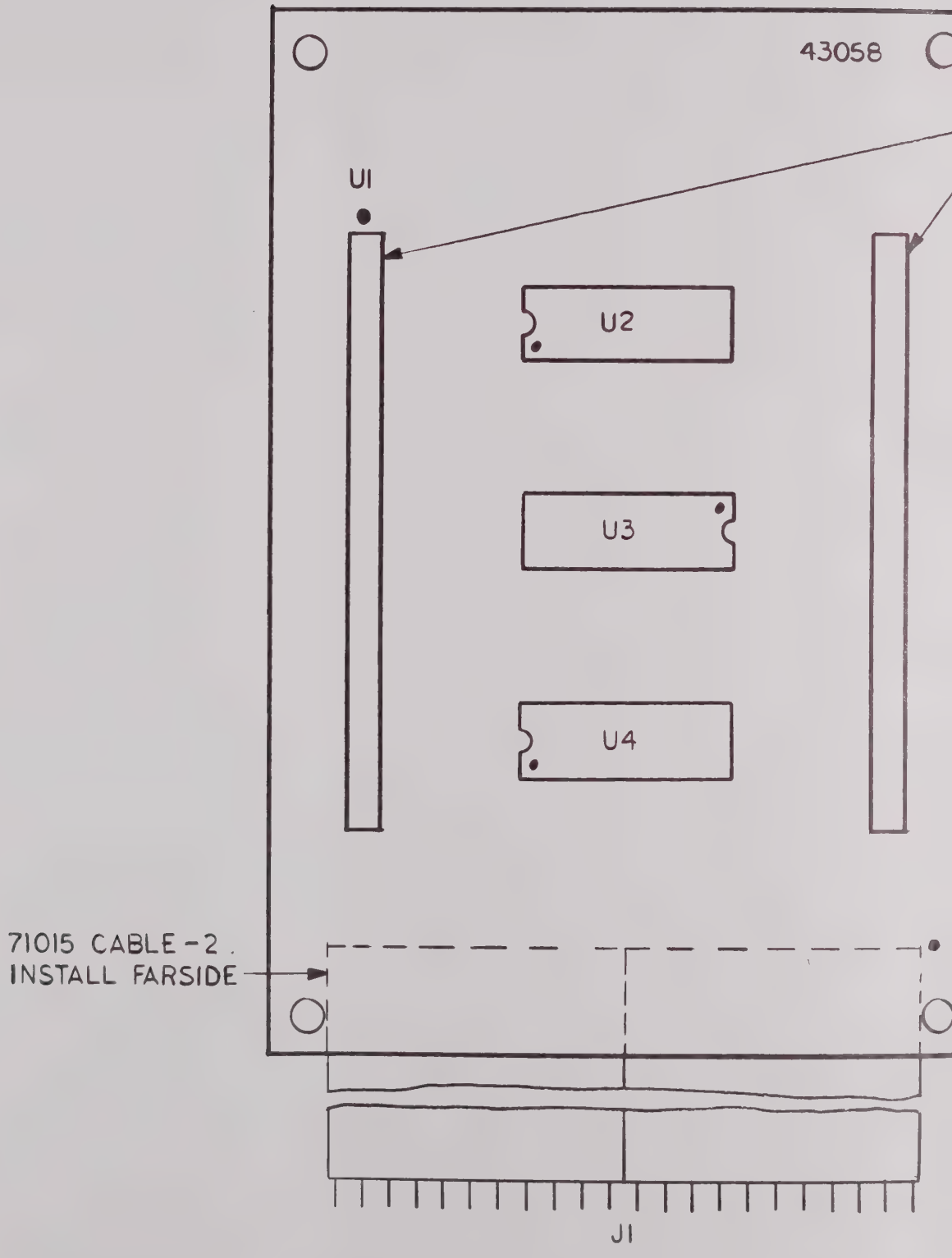
APPROVALS	DATE
DRAWN SP	7/18/83
CHECKED	

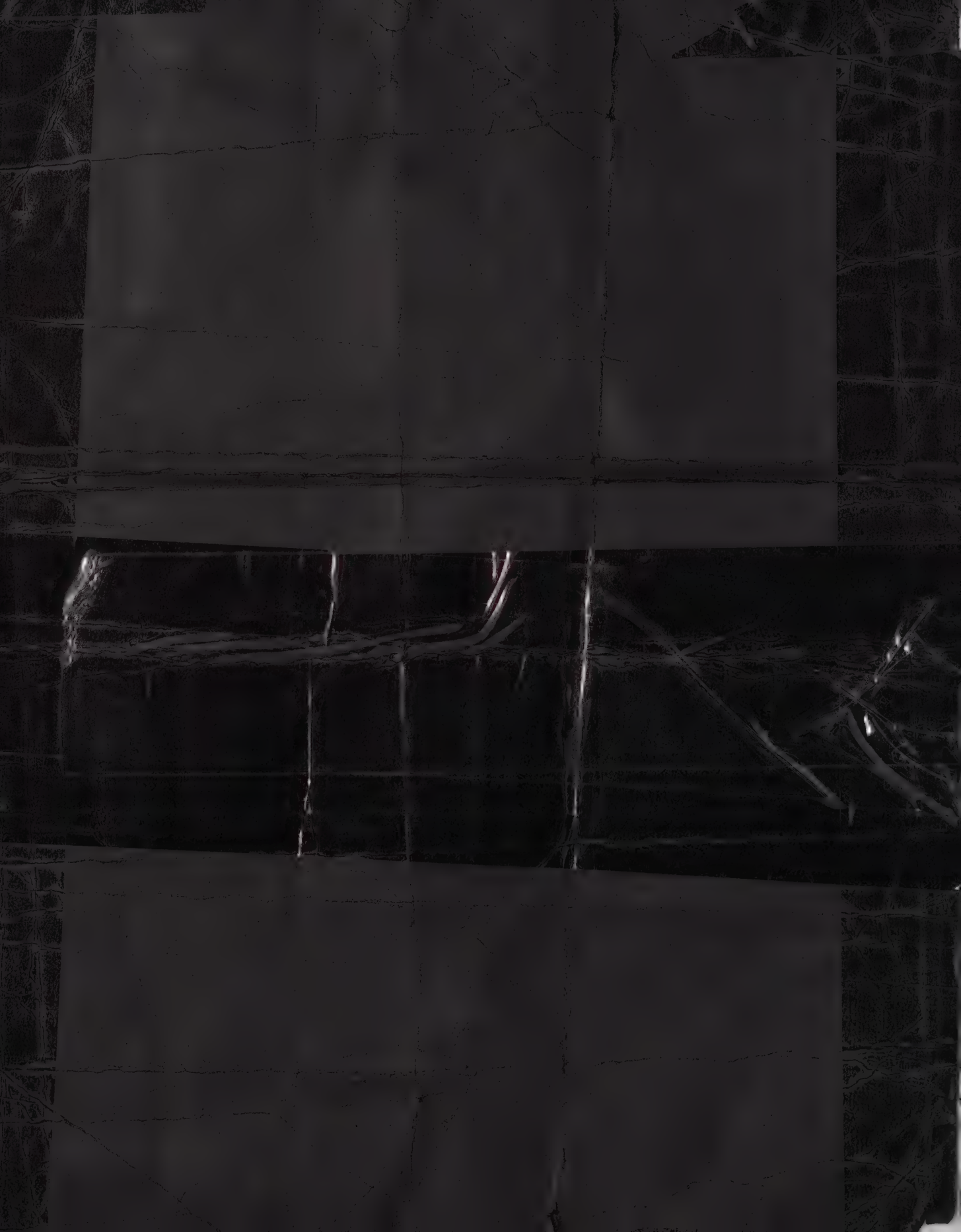
SWITCH PC BOARD ASSEMBLY

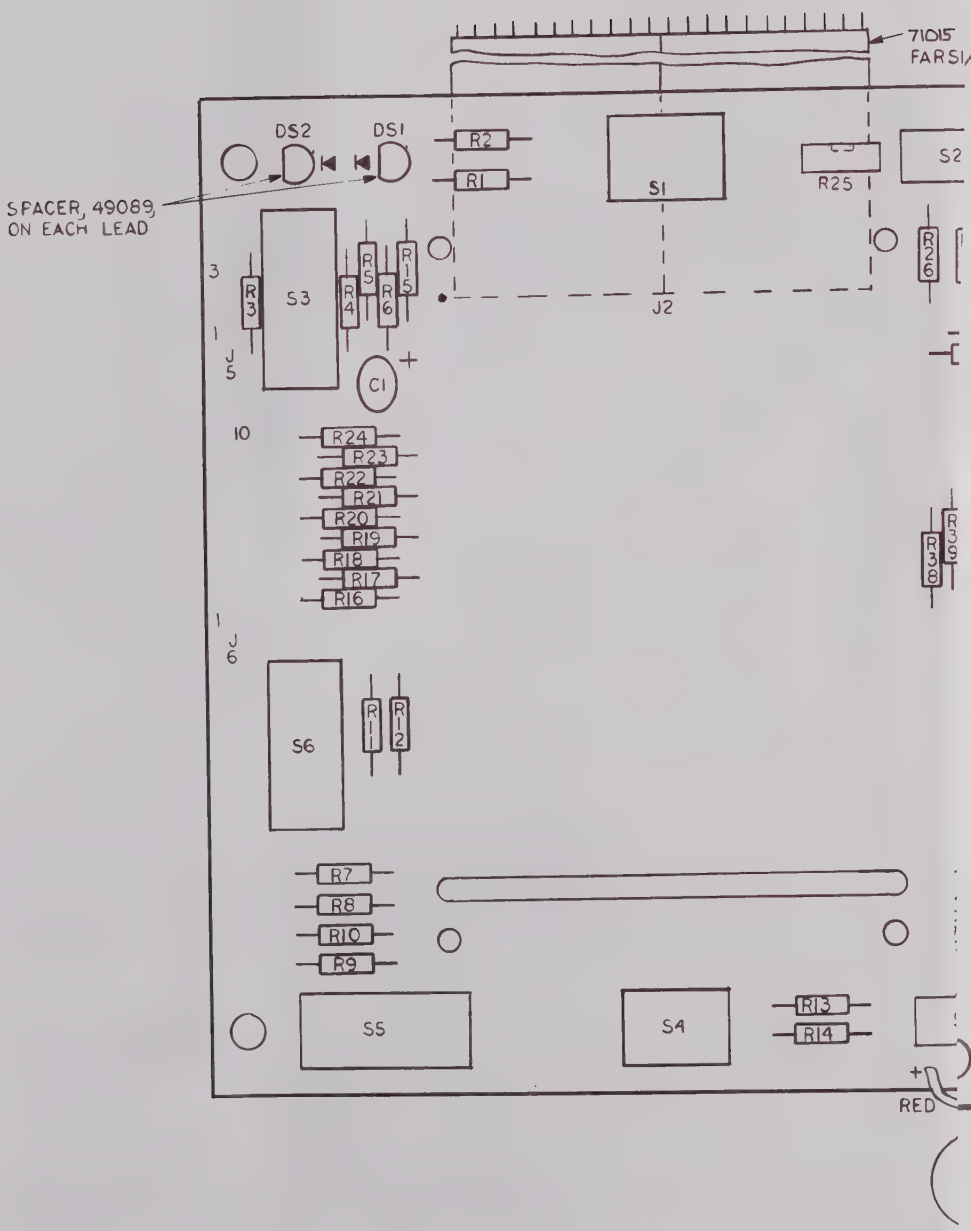
SCALE 2 to 1

SHEET 1 OF 1

DRAWING NO. 6771002-AS


43058
U1
U2
U3
U4
71015 CABLE-2.
INSTALL FARSIDE
J1




71015
FARSI
DS2
DS1
R2
R1
S1
R25
S2
SPACER, 49089,
ON EACH LEAD
3
R3
S3
R4
R5
R6
R15
J2
R26
1
J5
C1
+
10
R24
R23
R22
R21
R20
R19
R18
R17
R16
R36
1
J6
S6
R11
R12
R7
R8
R10
R9
S5
S4
R13
R14
+
RED

HEADER, 42149, 2 PLACES

PLUG LCD (NOT SHOWN), 04006,
INTO HEADERS AFTER AFFIXING
LCD OVERLAY, 6770005, TO LCD
INSTALL LCD SO THE "BPM" SECTION
OF OVERLAY IS NEXT TO THE "UI" ON PCB

REV	DESCRIPTION	DATE/BY
A	RELEASE TO PRODUCTION ECO 1119	10/17/83 SP

BIO-TEK
INSTRUMENTS, INC.
[redacted]
HIGHLAND PARK, BOX 998
WINOOSKI, VT 05404-0998

DISPLAY PC BOARD

APPROVALS	DATE	SCALE 2 TO 1	DRAWING NO. 6771003-AS
DRAWN SP	7/25/83	SHEET 1 OF 1	
CHECKED			

STANPAT PRODUCTS INC PORT WASHINGTON N.Y.

08/07/86 BILL OF MATERIAL PAGE 1

KITTING LIST

6771001 677 MAIN PCB ASBY RUN # NANCY QTY: 1

PART #	DESCRIPTION	REFERENCE	MEMO CODE	QTY	EXT	ISSUES
*	*** REVISION LEVEL ***	F 05-06-86	99	.00	.00	
21004	DIODE 1N4148 SIGNAL	CR1	2	1.00	1.00	
23007	OP AMP 324 QUAD	U13	8	1.00	1.00	
23027	OP AMP 358 DUAL	U12	8	1.00	1.00	
23039	OP AMP LM11 BIPOLAR	U11	8	1.00	1.00	
25002	IC 4538 MULTIVIB DUAL MS	U4	8	1.00	1.00	
25012	IC 4069 HEX INVERTER	U5	8	1.00	1.00	
25026	IC 74C373 3-ST OCT LT FF	U3	8	1.00	1.00	
25059	IC 4076 4-BIT LATCH	U6,7	8	2.00	2.00	
26001	TRANSISTOR 2N4126 SIG PNP	Q3	8	1.00	1.00	
26002	TRANSISTOR 2N4123 SIG NPN	Q1	8	1.00	1.00	
27006	TRANSISTOR 2N4392 FET NCH	Q2	8	1.00	1.00	
28003	VOLT REF 1.235	Q4	8	1.00	1.00	
28010	IC 7660 DC TO DC CONVERTR	U14	8	1.00	1.00	
29008	IC 7524 8-BIT BUF D/A CON	U10	8	1.00	1.00	
29018	IC 80C35 8-BIT CMOS uP	U1	8	1.00	1.00	
29025	IC 7528 8-BIT D/A CONVERT	U9	8	1.00	1.00	
29026	IC 7545 12-BIT D/A CONVTR	U8	8	1.00	1.00	
31100	RES 10.0 OHM 5% 1/4W	R29	2	1.00	1.00	
31103	RES 10.0K OHM 5% 1/4W	R4	2	1.00	1.00	

08/07/86 BILL OF MATERIAL PAGE 2

KITTING LIST

6771001 677 MAIN PCB ASBY RUN # NANCY QTY: 1

PART #	DESCRIPTION	REFERENCE	MEMO CODE	QTY	EXT	ISSUES
31104	RES 100.0K OHM 5% 1/4W	R1,33	2	2.00	2.00	
31105	RES 1.0M OHM 5% 1/4W	R7	2	1.00	1.00	
31152	RES 1.5K OHM 5% 1/4W	R28	2	1.00	1.00	
31153	RES 15.0K OHM 5% 1/4W	R5	2	1.00	1.00	
31202	RES 2.0K OHM 5% 1/4W	R14,20,27	2	3.00	3.00	
31479	RES 4.7 OHM 5% 1/4W	R8	2	1.00	1.00	
31514	RES 510.0K OHM 5% 1/4W	R3,6	2	2.00	2.00	
31752	RES 7.5K OHM 5% 1/4W	R30	2	1.00	1.00	
31823	RES 82.0K OHM 5% 1/4W	R13	2	1.00	1.00	
32008	RES 30.90K OHM 1% 1/4W	R31	2	1.00	1.00	
32018	RES 39.20K OHM 1% 1/4W	R11,12	2	2.00	2.00	
32028	RES 49.90K OHM 1% 1/4W	R2	2	1.00	1.00	
32030	RES 100.00K OHM 1% 1/4W	R17	2	1.00	1.00	
32042	RES 10.00K OHM 1% 1/4W	R32	2	1.00	1.00	
32114	RES 19.60K OHM 1% 1/4W	R18	2	1.00	1.00	
32186	RES 365.00K OHM 1% 1/4W	R16	2	1.00	1.00	
32188	RES 97.60K OHM 1% 1/4W	R15	2	1.00	1.00	
32200	RES 210.00 OHM 1% 1/4W	R9	2	1.00	1.00	
35001	TRIMPOT 100K, 25T	R23,19	6	2.00	2.00	
35019	TRIMPOT 50 OHM, 25T	R10	6	1.00	1.00	

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KITTING LIST

6771001 677 MAIN PCB ASBY RUN # NANCY QTY: 1

PART #	DESCRIPTION	REFERENCE	MEMO CODE	QTY	EXT	ISSUES
35021	TRIMPOT 20 OHM, 25T	R22,24	6	2.00	2.00	
37015	RESNET 330 OHM 4R 8P SIP	R21,25	6	2.00	2.00	
42097	HEDR 11-S RTANG BURNDY	J1,2	6	4.00	4.00	
42150	HEDR 12-P .100 RTANG BRKS	J3,4	6	1.00	1.00	
43060	PCB MPS MAIN	REV B	8	1.00	1.00	
49014	TERM PCB	TP	2	10.00	10.00	
49025	SOCKET I.C. 24-PIN DIP		6	1.00	1.00	
49078	CRYSTAL 6 MHZ	CY1	6	1.00	1.00	
49088	SPACER TEFLON 1/16"		2	15.00	15.00	
6770300	677 SOFTWARE ASSEMBLY	U2	1	1.00	1.00	
81005	CAP 47 uF 16V ELEC	C14	2	1.00	1.00	
82001	CAP 4.7 uF 10V TANT	C15	8	1.00	1.00	
82003	CAP 10 uF 25V TANT	C11,12	8	2.00	2.00	
82005	CAP 1 uF 35V TANT	C1,7	8	2.00	2.00	
83007	CAP .01 uF 50V DISC	C8,16	2	2.00	2.00	
83014	CAP 20 pF 1000V DISC	C3,4	8	2.00	2.00	
83019	CAP .1 uF 100V DISC	C2	8	1.00	1.00	
83021	CAP 1000 pF 200V DISC	C13	8	1.00	1.00	
85002	CAP .01 uF 100V 1%	C5	8	1.00	1.00	
85003	CAP .1 uF 50V 1%	C6,9,10	8	3.00	3.00	

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KITTING LIST

6771002 677 SWITCH PCB ASBY RUN # NANCY QTY: 1

PART #	DESCRIPTION	REFERENCE	MEMO CODE	QTY	EXT	ISSUES
*	*** REVISION LEVEL ***	E 2-20-85	99	.00	.00	
03001	LED GREEN	DS2	6	1.00	1.00	
03002	LED RED	DS1	6	1.00	1.00	
22038	DIODE 1N4742 ZENER 12V	D1	6	1.00	1.00	
31104	RES 100.0K OHM 5% 1/4W	R3	2	1.00	1.00	
31200	RES 20.0 OHM 5% 1/4W	R43	2	1.00	1.00	
31201	RES 200.0 OHM 5% 1/4W	R20,22	2	2.00	2.00	
31240	RES 24.0 OHM 5% 1/4W	R42	2	1.00	1.00	
31241	RES 240.0 OHM 5% 1/4W	R24	2	1.00	1.00	
31271	RES 270.0 OHM 5% 1/4W	R23	2	1.00	1.00	
31331	RES 330.0 OHM 5% 1/4W	R2	2	1.00	1.00	
31332	RES 3.3K OHM 5% 1/4W	R21	2	1.00	1.00	
31360	RES 36.0 OHM 5% 1/4W	R41,46	2	2.00	2.00	
31361	RES 360.0 OHM 5% 1/4W	R47	2	1.00	1.00	
31390	RES 39.0 OHM 5% 1/4W	R45	2	1.00	1.00	
31391	RES 390.0 OHM 5% 1/4W	R18,19	2	2.00	2.00	
31471	RES 470.0 OHM 5% 1/4W	R1	2	1.00	1.00	
31479	RES 4.7 OHM 5% 1/4W	R13	2	1.00	1.00	
31820	RES 82.0 OHM 5% 1/4W	R44	2	1.00	1.00	
32012	RES 34.00K OHM 1% 1/4W	R27	2	1.00	1.00	

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KITTING LIST

6771002 677 SWITCH PCB ASBY RUN # NANCY QTY: 1

PART #	DESCRIPTION	REFERENCE	MEMO CODE	QTY	EXT	ISSUES
32013	RES 34.80K OHM 1% 1/4W	R5,30	2	2.00	2.00	
32047	RES 1.00K OHM 1% 1/4W	R11	2	1.00	1.00	
32072	RES 69.80K OHM 1% 1/4W	R6	2	1.00	1.00	
32087	RES 17.40K OHM 1% 1/4W	R4	2	1.00	1.00	
32099	RES 10.00 OHM 1% 1/4W	R17	2	1.00	1.00	
32122	RES 226.00 OHM 1% 1/4W	R8	2	1.00	1.00	
32194	RES 13.30 OHM 1% 1/4W	R14	2	1.00	1.00	
32195	RES 22.10 OHM 1% 1/4W	R16	2	1.00	1.00	
32196	RES 64.90 OHM 1% 1/4W	R7	2	1.00	1.00	
32197	RES 113.00 OHM 1% 1/4W	R10	2	1.00	1.00	
32198	RES 174.00 OHM 1% 1/4W	R9	2	1.00	1.00	
32199	RES 499.00 OHM 1% 1/4W	R12	2	1.00	1.00	
32203	RES 348.00K OHM 1% 1/4W	R15	2	1.00	1.00	
32225	RES 178.00 OHM 1% 1/4W	R28,31,48,49	2	4.00	4.00	
32226	RES 4.22K OHM 1% 1/4W	R26	2	1.00	1.00	
32227	RES 280.00K OHM 1% 1/4W	R29	2	1.00	1.00	
35003	TRIMPOT 2K, 1T	R25	6	1.00	1.00	
37016	RES 1.18K OHM .5% RN55C	R34	6	1.00	1.00	
37017	RES 1.33K OHM .5% RN55C	R33	6	1.00	1.00	
37018	RES 1.78K OHM .5% RN55C	R32	6	1.00	1.00	

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KITTING LIST

6771002 677 SWITCH PCB ASBY RUN # NANCY QTY: 1

PART #	DESCRIPTION	REFERENCE	MEMO CODE	QTY	EXT	ISSUES
37019	RES 3.16K OHM .5% RN55C	R37	6	1.00	1.00	
37020	RES 3.57K OHM .5% RN55C	R36	6	1.00	1.00	
37021	RES 4.75K OHM .5% RN55C	R35	6	1.00	1.00	
37022	RES 15.80K OHM .5% RN55C	R40	6	1.00	1.00	
37023	RES 18.20K OHM .5% RN55C	R39	6	1.00	1.00	
37024	RES 24.30K OHM .5% RN55C	R38	6	1.00	1.00	
43059	PCB MPS SWITCHBOARD		8	1.00	1.00	
47005	BATTERYCLIP 9V		6	1.00	1.00	
49088	SPACER TEFLON 1/16"		2	14.00	14.00	
49089	SPACER TEFLON 3/16"		2	4.00	4.00	
53001	SW SLIDE 4-POS 1-POLE GLD	S3	12	1.00	1.00	
53002	SW SLIDE 3-POS 3-POLE GLD	S5,6	12	2.00	2.00	
53005	SW SLIDE DPDT GLD	S2,8	12	2.00	2.00	
53008	SW SLIDE 4PDT GLD	S1,4	12	2.00	2.00	
53009	SW SLIDE 4P3T GLD	S7	12	1.00	1.00	
71015	JUMPER 2" 11-COND	J2	8	2.00	2.00	
82002	CAP 33 uF 10V TANT	C1	8	1.00	1.00	
82003	CAP 10 uF 25V TANT	C2	8	1.00	1.00	

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KITTING LIST

6771003 677 DISPLAY PCB ASBY RUN # NANCY QTY: 1

PART #	DESCRIPTION	REFERENCE	MEMO CODE	QTY	EXT	ISSUES
*	*** REVISION LEVEL ***	A	99	.00	.00	
04006	DISPLAY LCD BAR GRAPH	U1	12	1.00	1.00	
25060	IC 4051 8:1 MULTIPLEXER	U2,3,4	8	3.00	3.00	
42149	HEDR 22-S .100 BRKS	FOR U1	6	2.00	2.00	
43058	PCB MPS LCD		8	1.00	1.00	
6770005	OVERLAY MPS LCD CLEAR		8	1.00	1.00	
71015	JUMPER 2" 11-COND	J1	8	2.00	2.00	

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KITTING LIST

6771004 677 MPS END PANEL ASBY RUN # NANCY QTY: 1

PART #	DESCRIPTION	REFERENCE	MEMO CODE	QTY	EXT	ISSUES
*	*** REVISION LEVEL ***	A	99	.00	.00	
12009	SCR PAN 6-32x3/4 SS SLOT		2	10.00	10.00	
15001	LOCKNUT 2-56 STEEL		2	8.00	8.00	
16009	LKWSHR #6 INT TOOTH STEEL		2	20.00	20.00	
42006	BNC CHASSIS SINGLE		6	1.00	1.00	
42012	TIP JACK CHASSIS		6	1.00	1.00	
42031	TERM RING 3/8 22-16 GA		2	1.00	1.00	
42145	RECPT 6-P CHASS ALFIN MIL		6	2.00	2.00	
42148	RECPT TWIN COAX BNC CHASS		6	2.00	2.00	
43061	PCB MPS END PANEL		8	1.00	1.00	
48041	ADAPTER ECG		6	10.00	10.00	
48042	ADAPTER RETAINER ECG		6	10.00	10.00	
6770001	SPACER BNC JACK MPS		90	1.00	1.00	
6770002	SPACER TIP JACK MPS		90	1.00	1.00	
6770007	OVERLAY MPS BTM END PANL		8	1.00	1.00	
6770008	OVERLAY MPS TOP END PANL		8	1.00	1.00	
6770009	PANEL MPS BOTTOM END		10	1.00	1.00	
71003	CABLE RIBN 10-CON 22 AWG	A/R	2	.00	.00	
71019	CABLE FLAT 10-COND 24 AWG	A/R	2	.00	.00	
7770020	SPACER ECG		90	2.00	2.00	

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KITTING LIST

6771005 677 MPS CASE ASBY RUN # NANCY QTY: 1

PART #	DESCRIPTION	REFERENCE	MEMO CODE	QTY	EXT	ISSUES
*	*** REVISION LEVEL ***	A	99	.00	.00	
11010	SCR FH 6-32x5/16 SS SLOT		2	4.00	4.00	
44108	ACCESSORY POUCH		6	1.00	1.00	
49070	SPACER MF 6-32x.500 BR HX		6	4.00	4.00	
49156	FOOT RUBBER GREY		2	4.00	4.00	
49173	TAPE DOUBLE SIDED 3/4"W	1.5"	2	.13	.13	
52029	TOUCH PANEL 4-SW		8	1.00	1.00	
52030	TOUCH PANEL 6-SW		8	1.00	1.00	
6770003	BEZEL LCD CLEAR MPS		90	1.00	1.00	
6770004	OVERLAY MPS FRONT PANEL		8	1.00	1.00	
6770010	CASE MPS DRILLED *44144		90	1.00	1.00	

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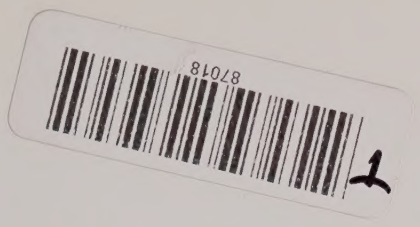
KITTING LIST

6771006 677 MPS FINAL ASBY RUN # NANCY QTY: 1

PART #	DESCRIPTION	REFERENCE	MEMO CODE	QTY	EXT	ISSUES
*	*** REVISION LEVEL ***	B 5-16-84	99	.00	.00	
12007	SCR PAN 6-32x3/8 SS SLOT		2	4.00	4.00	
16009	LKWSHR #6 INT TOOTH STEEL		2	8.00	8.00	
18001	SCR FH 4-40x1/2 BLK NYLON		2	4.00	4.00	
18004	NUT 4-40 B/W NYLON		2	8.00	8.00	
47002	BATTERY 9V ALKALINE		6	1.00	1.00	
49157	SPACER FF 6-32x.625 SS HX		6	4.00	4.00	
6770031	677 MPS TEMPERATURE CABLE		3	1.00	1.00	
6771001	677 MAIN PCB ASBY		1	1.00	1.00	
6771002	677 SWITCH PCB ASBY		1	1.00	1.00	
6771003	677 DISPLAY PCB ASBY		1	1.00	1.00	
6771004	677 MPS END PANEL ASBY		1	1.00	1.00	
6771005	677 MPS CASE ASBY		1	1.00	1.00	
6771008	677 MPS SHIPPING LIST		1	1.00	1.00	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